XL JULY, 1956 No. 2

THE PHILIPPINE AGRICULTURIST

JOURNAL OF THE COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
University of the Philippines

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UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A
Published at College, Laguna

COMMONWEALTH MYCOLOGICAL INSTITUTE
25 JAN 1957

The Philippine Agriculturist

Journal of the College of Agriculture and Central Experiment Station
University of the Philippines

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The Philippine Agriculturist is published monthly except in April and May by the College of Agriculture and Central Experiment Station, University of the Philippines, College, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱0.75 in the Philippines and $0.50 elsewhere.

Authors of articles appearing in The Philippine Agriculturist are severally responsible for the opinions expressed therein.

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REACTION OF PACOL-ABACÁ F_1 HYBRIDS TO ABACÁ MOSAIC AND BUNCHY-TOP [1]

D. L. UMALI, F. A. BERNARDO, and G. O. OCFEMIA

Pacol x abacá F_1 hybrids showed complete resistance or immunity to abacá mosaic and bunchy-top diseases.

So far no abacá variety is known to be resistant to mosaic (*Marmor cucumeris* Holmes) and bunchy-top (*Marmor abacá* Holmes), the two major diseases of abacá or Manila hemp (*Musa textilis* Née). It seems, however, that resistance can be bred into abacá by crossing it with pacol (*Musa balbisiana* Colla) which is highly resistant, if not immune, to the two diseases. There has been considerable interest in the breeding of resistant abacá clones because the growing of resistant lines as a control measure is more permanent and eventually less expensive for the industry.

Pacol-abacá hybrids produced in the Division of Plant Breeding, Department of Agronomy, in 1953 were studied for their reaction to abacá mosaic and bunchy-top from November, 1953, to January, 1955.

MATERIALS AND METHODS

About 1,200 F_1 seedlings of pacol x Maguindanao in seed flats of 40 seedlings each were divided into two groups. One group was infected with abacá mosaic and the other with bunchy-top. Ninety-seven Maguindanao seedlings and 49 of pacol were used as control plants. All the F_1 and control seedlings were two months old at the start of the inoculation experiments.

Ocfemia and Celino [2] and Celino and Ocfemia [3] reported that abacá mosaic is transmitted by four species of aphids. Two of these species were used in the experiments: *Aphis gossypii* Glover, found teeming around gumamela flower buds throughout the year, and *A. maidis* Fitch., found in abundance on corn during the tasseling stage.

Pentalonia nigronervosa Coq. from abacá was used for transmission of bunchy-top virus.

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[1] Central Experiment Station Contribution No. 1889.
[2] G. O. Ocfemia and M. S. Celino, *Philippine Agriculturist*, 27, 593 (1938).
[3] M. S. Celino and G. O. Ocfemia, *Philippine Agriculturist*, 30, 70 (1941).

To test for reaction to the two diseases, viruliferous insect vectors were made to feed on the experimental hybrids and on healthy abacá and pacol seedlings. All plants that did not show symptoms of the disease were used in further transmission tests several times.

To test for tolerance, nonviruliferous aphids were colonized on hybrid plants that did not exhibit any apparent symptoms of the diseases. The aphids were then transferred to and allowed to feed on healthy abacá plants. For check, aphids taken from their natural hosts were allowed to feed on healthy abacá.

Fifteen mosaicked and ten bunchy-top-infected abacá seedlings and two mosaicked *Canna indica* Linn. plants were used as sources of virus. The aphids were transferred to the experimental plants with the moistened end of a camel's hair brush. They were allowed to remain on the experimental and check plants indefinitely. *A. maidis* was difficult to keep alive on abacá as this plant is not its normal host.

EXPERIMENTAL RESULTS AND DISCUSSION

Reaction to mosaic disease. From November to December, 1955, ten *Aphis maidis* which had fed on mosaicked abacá were transferred to each of 42 healthy abacá and 49 pacol seedlings used as checks. No symptoms or signs of mosaic appeared on the hybrid plants. Only one abacá control showed definite symptoms of infection on February 9, 1954.

The inoculation was repeated using *Aphis gossypii* which, according to Ocfemia, Macaspac, and Hsieh,[4] could transmit the disease to abacá after feeding on mosaicked *Canna indica* for only five minutes. From February to April, 1954, the insect vectors from gumamela were allowed to feed on mosaicked *Canna indica* plants. After 24 hours, 10 were transferred to each of the 600 hybrid and check plants. No symptoms appeared on the hybrids, whereas only three of the 42 abacá check plants showed the characteristic symptoms of mosaic in May, 1954.

The poor transmission to the abacá control may be attributed to the following defects of the mass treatment employed:

(a) The 600 heterotic seedlings included in the study grew so rapidly that cheesecloth bags, to keep out other insects and some species of spiders which feed on aphids, could not be used throughout the experiment.

[4] G. O. Ocfemia, I. S. Macaspac, and Hsieh Feng Yuan, *Philippine Agriculturist*, 30, 357 (1941).

(b) The plants were planted so close together in the flats that the insect vectors could easily migrate from one plant to another. It is probable that not enough virus-laden aphids fed on some of the plants. The least number of *A. maidis* needed to transmit mosaic from abacá has not been determined, but Ocfemia, Macaspac, and Hsieh [5] reported that at least five *A. gossypii* were required to transmit mosaic from *Canna indica* to abacá.

(c) Intensive inoculation, or the use of more insect vectors to a plant, and further repetition of the treatments could not be made owing to the great number of plants involved and the difficulty of transferring aphids and keeping them alive.

Twenty hybrids selected at random were potted in October, 1954, for intensive inoculation. This time, 150 *Aphis maidis* that had fed on mosaic-infected abacá for 24 hours were transferred to each of the plants. The same number of viruliferous aphids were transferred to five abacá seedlings used as checks. All plants were covered with cheesecloth bags. The youngest expanded or unfurled leaves of the five abacá checks showed mottling even as early as five days after inoculation. The 20 hybrid and five pacol seedlings showed no symptoms of mosaic infection even after the third inoculation in November, 1954.

Tolerance of mosaic. Five of the potted hybrids that did not show any apparent symptom of the disease were sprayed with soap solution to destroy any surviving virus-laden aphids. A fresh batch of *A. maidis* from healthy corn plants was allowed to feed on the five pacol-abacá hybrids for 24 hours. Then 150 individuals were transferred to three 3-month-old abacá seedlings. The abacá plants did not show any symptom characteristic of mosaic disease even after three months. This result confirms the absence of mosaic virus in the tissues of the hybrid plants.

Reaction to bunchy-top disease. From December, 1953, to January, 1954, ten *Pentalonia nigronervosa* that had fed on abacá plants infected with bunchy-top were allowed to colonize on each of the 600 hybrids. The same number of viruliferous aphids were transferred to 36 healthy abacá pacol seedlings used as checks.

One month later, half of the abacá checks exhibited symptoms of bunchy-top infection, whereas none of the hybrids showed symptoms of the disease. After one month more, however, some hybrids were suspected of exhibiting symptoms of bunchy-top in the incipient

[5] *Ibid.*

stage. Three months later, some hybrids were observed to be stunted in growth. Production of new leaf shoots in some was retarded, and short and narrow leaves developed. Stalks grew slender and the older leaves which turned yellow finally dried up. A close and careful study of the plants, however, did not reveal any reliable symptom of bunchy-top disease as described by Ocfemia.[6] There was no clearing of leaf veins, the most reliable symptom of bunchy-top.

Tolerance of bunchy-top. In September, 1954, six of the short- and narrow-leaved hybrids were transplanted to clay loam soil. A fresh batch of *P. nigronervosa* taken from healthy abacá plants was transferred to the potted hybrids and allowed to feed and multiply for about four weeks. Twenty adults from these hybrids were colonized on five healthy abacá seedlings. Aphids from healthy abacá were transferred to a healthy abacá seedling used as check. All plants were bagged. Not one of the abacá seedlings exhibited symptoms of bunchy-top even after three months. Meanwhile, the potted hybrid plants which were given proper care gradually recovered and, in one month, were again healthy looking and vigorous.

In view of the results, it was suspected that the production of short and narrow leaves and the somewhat stunted appearance of some of the hybrid plants were not due to bunchy-top infection but rather to plant nutrient deficiency of the soil in the flats.

For testing resistance to bunchy-top disease further, 20 hybrid plants selected at random were potted in October, 1954, in clay loam soil. Twenty *P. nigronervosa* that were allowed to feed on bunchy-top-infected plants were transferred to each of the potted hybrids and two abacá checks. Care was taken to make environmental factors most favorable to the plants.

Symptoms of bunchy-top infection were exhibited by the checks in late December, 1954. Until early January, 1955, no symptoms of the disease were shown by the experimental hybrids. The hybrids maintained their health and vigor although they were used again in another transmission test.

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[6] G. O. Ocfemia, *Amer. Jour. Bot.*, 17, 1 (1930).

THE RESPONSE TO FERTILIZATION OF LOWLAND RICE PLANTED AT DIFFERENT SPACINGS [1]

TEODORO C. CRUZ and SANTIAGO N. TILO [2]

Thailand rice planted during the wet season yielded 61.7 cavans to a hectare when planted at a spacing of 25 × 25 centimeters. This yield was higher than the yields obtained from spacings of 50 × 50 centimeters and 15 × 15 centimeters. In the 15 × 15 spacing, best results were obtained without fertilization; yields decreased as the nitrogen in the fertilizer was increased. In the 25 × 25 spacing, application of fertilizer did not increase yields. In the 50 × 50 spacing, the yield increased as the nitrogen content of the fertilizer was increased.

Increasing the distance of spacing produced taller plants, longer panicles, and more tillers with panicles; decreased straw yields, grain to straw ratio, and lodging. Increasing the nitrogen in the fertilizers increased the yield of straw, the grain to straw ratio, and lodging; produced taller plants and longer panicles; and decreased the percentage of filled grains.

Literature on the population or spacing of rice plants of different varieties and its relation to fertilizer applications is very limited. The object of this study was to determine the response to fertilizer applications of lowland rice, variety Thailand, planted at three different spacings. The study was conducted from April 30, 1955, to December, 1955, in a farmer-cooperator's irrigated lowland rice field in Pagsanjan, Laguna, and in the laboratory of the Soils Department.

MATERIALS AND METHODS

The chemical analysis of the experimental area, as represented by a composite sample from replications I and II and another from replications III and IV, follows:

REPLICATION	pH	O.M. %	P ppm.	M.E. PER 100 GRAMS SOIL					
				CEC	Ca	Mg	Mn	K	Na
I & II	6.65	3.3	115	28.5	14.4	10.0	0.05	.30	.25
III & IV	6.15	3.4	93	27.0	13.0	10.0	0.04	.79	.10

[1] Central Experiment Station Contribution No. 1890.

[2] The writers thank Dr. L. E. Nelson, visiting professor from Cornell University, and Mr. J. G. Davide for advice and criticism given during the work and the preparation of the manuscript.

A split plot design was used with spacings assigned to the main plots and fertility levels to the subplots. The distances tested were three: (a) 50 × 50 centimeters, with one plant to each hill, the plants planted in rows; (b) 25 × 25 centimeters, two plants to a hill planted in rows; (c) nonuniform planting at an approximate distance of 15 × 15 centimeters between hills, not planted in straight rows, with two to four plants to a hill. Field counts after harvest showed the average number of hills to a square meter in the 15 × 15 spacing to be 44. Plots planted in rows had 4 and 16 hills to a square meter for the 50 × 50 and 25 × 25 centimeter spacings, respectively.

The subplots were 12 × 6 meters in replication I and 13 × 6 in replications II, III, and IV; the size of the harvested area was 55 square meters in replication I and 60 square meters in the three other replications.

Nitrogen in the form of ammonium sulfate was applied in three applications: 25 per cent 12 days after transplanting; 35 per cent 22 days after transplanting; and 40 per cent 53 days after transplanting. The field was drained before each application of the fertilizer and reflooded five days after. No dikes separated the different treatments. Phosphorus, in the form of superphosphate, and potassium, in the form of muriate of potash, was broadcast with the first application of nitrogen.

RESULTS AND DISCUSSION

Yield of grains in cavans per hectare. The means of the fertilizer treatments in all spacings indicated no significant difference due to fertilization (table 1). Differences due to spacing were significant at the 5 per cent level, the highest yields being obtained from the 25 × 25 centimeter spacing. An examination of the spacing × fertility interaction revealed that without any fertilizer the yield increased as the population was increased, the 25 × 25 spacing being almost as good as the 15 × 15 spacing. As the fertility levels increased, the yields of the 50 × 50 spacing decreased, those of the 15 × 15 spacing decreased, and those of the 25 × 25 spacing were not affected.

These results indicate that in the 50 × 50 spacing there were not enough plants to utilize all the available nutrients in the soil, i.e., the root system could not exploit all of the soil volume available to it. The fertilizer replenished the nutrients in the root zone and increased the yield. In the 15 × 15 spacing addition of fertilizer in-

TABLE 1.—*Yield of grains in cavans per hectare (15% moisture) as affected by spacing and fertilization*

FERTILIZER TREATMENT	SPACING			FERTILIZER MEAN
	50 × 50	25 × 25	15 × 15	
0-0-0	44.8	60.1	63.3	56.1
30-90-90	52.8	61.2	59.0	57.7
60-90-90	54.5	62.0	55.1	57.2
90-90-90	61.0	63.4	46.5	57.0
Spacing means	53.3	61.7	56.0	

	L.S.M.D. 5%	1%
Fertilizer	N.S.	—
Spacing	5.14	N.S.
F × S	11.63	N.S.
C.V. (Spacing)		10.4%
C.V. (Fertilizer)		14.1%

creased lodging, which resulted in a decrease in yield. In the 25 × 25 spacing, the slight increase in yield due to fertilization was probably counteracted by slightly increased lodging so that little difference in yield was obtained.

Yield of straw in kilograms per hectare. The fertilizer means shown in table 2 indicate that straw yields for the 30-90-90, 60-90-90, and 90-90-90 treatments were significantly greater at the 5 per cent level than those of the control. Differences between fertilized treatments were not statistically significant.

TABLE 2.—*Yield of straw in kilograms per hectare (sundry weight) as affected by spacing and fertilization*

FERTILIZER TREATMENT	SPACING			FERTILIZER MEAN
	50 × 50	25 × 25	15 × 15	
0-0-0	3403	4111	6860	4791
30-90-90	3972	5594	8100	5888
60-90-90	4520	5348	9535	6468
90-90-90	4451	6235	7936	6207
Spacing means	4087	5322	8108	

	L.S.M.D. 5%	1%
Fertilizer	806	1088
Spacing	777	1177
F × S	N.S.	—
C.V. (Spacing)		15.4%
C.V. (Fertilizer)		16.5%

The 50 × 50 spacing yielded significantly less than either the 25 × 25 or the 15 × 15 spacing at the 1 per cent level. The 15 × 15 spacing yielded significantly more than the 50 × 50 spacing.

These results are in agreement with the finding of Almeda [3] and Kapp [4] that as the rate of nitrogen fertilization is increased, the dry matter of tops correspondingly increases. Kapp suggested the possibility of increasing the yield of straw out of proportion to the grain yield by heavy nitrogen fertilization.

The application of fertilizer had a significant effect on the grain to straw ratio at the 5 per cent level (table 3). At the 60-90-90 nitrogen level the straw to grain ratio increased. It also increased as the distance of planting was decreased. Obviously, either increasing the nitrogen or planting closer tended to increase the straw yield more than the grain yield.

TABLE 3.—*Grain to straw ratio as influenced by spacing and fertilization*

FERTILIZER TREATMENT	SPACING			FERTILIZER MEAN
	50 × 50	25 × 25	15 × 15	
0-0-0	1.64	1.62	2.80	2.38
30-90-90	1.76	2.02	3.17	2.32
60-90-90	1.93	2.01	4.20	2.71
90-90-90	1.59	2.34	4.02	2.65
Spacing means	1.73	2.00	3.55	

	L.S.M.D. 5%	1%
Fertilizer	0.41	N.S.
Spacing	0.37	0.56
F × S	N.S	—
C.V. (Spacing)		17.9%
C.V. (Fertilizer)		20.2%

Tiller and panicle counts. Counts of ten representative hills from each plot showed that fertilization did not influence the number of tillers and panicles to a hill but did increase the length of the panicles. More tillers with panicles and longer panicles were produced by wide-spaced plants than by close-spaced plants.

Height of plants at harvest. Taller plants were produced with wider spacings (table 4). The addition of fertilizer also produced taller plants at certain nitrogen levels, as shown by the fertilizer treatment means.

[3] V. T. Almeda, *Philippine Agriculturist*, 26, 446 (1937).
[4] L. C. Kapp, *Arkansas Agric. Exper. Sta. Bull.*, 291 (1933).

TABLE 4.—*Height of plants at harvest in centimeters as affected by spacing and fertilization*

FERTILIZER TREATMENT	SPACING			FERTILIZER MEAN
	50 × 50	25 × 25	15 × 15	
0-0-0	134.8	125.5	115.0	125.1
30-90-90	137.0	133.2	127.9	132.7
60-90-90	144.5	140.2	134.2	139.6
90-90-90	146.5	142.4	134.3	141.1
Spacing means	140.7	135.3	127.9	

	L.S.M.D. 5%	1%
Fertilizer	5.31	7.18
Spacing	6.31	9.56
F × S	N.S.	—
C.V. (Spacing)		5.4%
C.V. (Fertilizer)		4.7%

Percentage of filled grains. Spacing did not have any appreciable effect on the percentage of filled grains. However, the percentage of filled grains decreased as the amount of nitrogen was increased. The means of the different fertilizer treatments were 93.3, 91.6, and 88.6 per cent for treatments 0-0-0, 30-90-90, and 90-90-90, respectively, the mean difference of 1.05 being significant at the 5 per cent level.

Weight per 100 grains. Fertilization did not influence the weight of seeds, but spacing did. The 25 × 25 spacing produced the heaviest seeds (2.66 grams/100 seeds), followed by the 15 × 15 spacing (2.55 grams/100 seeds). The lightest seeds were obtained from the 50 × 50 spacing (2.50 grams/100 seeds), probably because of the uneven ripening of the grains.

Lodging. Lodging of Thailand rice was influenced by the spacing and the amount of nitrogen. Lodging was not observed in the 50 × 50 centimeter spacing and only at high nitrogen levels in the 25 × 25 spacing. In the 15 × 15 spacing, no lodging was observed in the check, but as the nitrogen in the fertilizer was increased, the percentage of lodging tended to increase.

Mulder observed that lodging in cereals was caused by excessive nitrogen which produced plants with less sturdy and less heavily lignified root systems.[5] This observation confirmed Libatique's conclusion that ammonium sulfate promoted root development when applied in moderate amounts but retarded it when applied excessive-

[5] E. G. Mulder, *Plant and Soil*, 5, 306 (1954).

ly.[6] Libatique also noted that plants fertilized heavily produced many but short roots.

Number of days to maturity and uniformity of ripening. Wider distances of planting delayed maturity. The days to maturity were 121, 125, and 129 for the 15×15, 25×25, and 50 × 50 spacings, respectively. The grains from the 15 × 15 and the 25 × 25 spacings matured evenly, but not those from the 50 × 50 spacing. Fertilizer applications did not influence the maturity date.

Insect pests. Rice stem borers and leaf folders which were observed during the sixth week of growth of the plants were controlled by spraying with 25 per cent DDT in "Gesarol" at a concentration of 10 ml. to a gallon of water three, six, and nine weeks after transplanting. During the milk stage of the grains, rice bug infestation was controlled by spraying four times during the susceptible stage with "Bladex" at a concentration of 10 ml. to a gallon.

No significant effects of insect infestation among the treatments were observed, probably because insect control was adequate.

Weeds. The same kind of weeds grew in all of the plots. Chemical weed control with 2,4-D Amine 25 per cent effectively controlled most of the weeds. The number of hand weedings needed to supplement chemical weed control varied with the distance of planting. Two hand weedings were needed for the 50 × 50 centimeter spacing, but only one for the 25 × 25 and 15 × 15 centimeter spacings. In the 50 × 50 spacing weeds competed with the rice plants more. Among closely spaced plants early shading of the weeds by the rice plants resulted in less weed competition.

The fertilizer treatments made no difference in weed growth.

General observation. The results of this experiment illustrate how the effects of fertilization can be modified by a single factor, in this case spacing. On this particular soil and with Thailand variety of rice, three different answers were obtained to the question, "How does fertilization affect the yield of Thailand rice?"

These results emphasize the necessity of taking into account all factors when interpreting fertilizer experiments. Among the most important of these factors are variety, spacing, time of planting and harvesting, weeds, insects, and weather.

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[6] P. P. Libatique, *Philippine Agriculturist*, 20, 121 (1931).

THE MINERAL NUTRITION OF YOUNG ABACÁ PLANTS [1]

J. R. VELASCO and T. E. CABRERA [2]

WITH FIVE TEXT FIGURES

Symptoms of nutrient deficiency in young suckers of abacá, grown in sand and watered with various modifications of Hoagland's solution B, varied in ease of induction and distinctness of change. For example, the yellowing in nitrogen deficiency occurred after a few weeks of treatment, whereas phosphate deficiency was not distinct even after 11 months of treatment; a certain chlorotic pattern was obtained with magnesium deficiency, whereas no clear-cut symptoms of potassium deficiency could be discerned.

Effects of nutrient deficiency on height and diameter of the trunk and number and area of leaves were superimposed on the effects of weather.

This study was undertaken to catalogue the different visual symptoms of nutrient deficiency in abacá (*Musa textilis* Née) and, incidentally, to see if information on the nutrition of abacá would throw some light on the mosaic virus problem.

MATERIALS AND METHODS

Corms of the Itom variety [3] of abacá were planted in sand on January 10, 1955, and watered with tap water. On April 16 when the suckers had three or four leaves, they were dug up, severed from the mother corms, and transferred to acid-washed sand [4] in pots. The plants were watered with Hoagland's solution No. 2 to help them get re-established. Of the 100 plants that were started in the sand, 52 uniform plants were subjected to different treatments on July 12 as follows:

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[1] Central Experiment Station Contribution No. 1891. Progress report of Research Project No. 439.

[2] The writers acknowledge the assistance in the project of Miss Lucila Espiritu.

[3] Grateful acknowledgment is due Mr. Epitacio Lanuza, Chief, Fiber Division, Bureau of Plant Industry, for furnishing the corms from the Guinobatan Experiment Station.

[4] Palawan white sand after washing with 2 per cent HCl contained 98.7 per cent SiO_2 and traces of iron and phosphate.

TREATMENT	KIND OF SALT AND MOLARITY			
	KNO_3 0.006	$Ca(NO_3)_2$ 0.004	$MgSO_4$ 0.002	$NH_4H_2PO_4$ 0.001
Complete	√	√	√	√
No N	(KCl)	($CaCl_2$)	√	(NaH_2PO_4)
No P	√	√	√	(NH_4Cl)
No S	√	√	($MgCl_2$)	√
No K	($NaNO_3$)	√	√	√
No Ca	√	($NaNO_3$)	√	√
No Mg	√	√	(Na_2SO_4)	√
			No B	
			No Cu	
			No Fe	
			No Mn	
			No Mo	
			No Zn	

The complete culture solution was Hoagland's solution No. 2. The salts in parentheses were substituted for the corresponding salts of Hoagland's at the same concentrations. A micro-nutrient mixture (Arnon)[5] was used in all cultures except in those where micro-nutrient deficiencies were being induced.

Each plant was given 1 liter of solution every week during the first two months of the treatment and 2 liters thereafter. On sunny days the culture solution was supplemented by a liter or two of distilled water to replace the water lost from too much evaporation.

RESULTS

Visual changes. The characters particularly noted were the pattern of color in the leaves and its rate of change and the drying of the leaves. A symptom was considered typical when three out of the four plants exhibited it.

Complete-solution culture—Three plants in this lot were dark green and healthy. One plant was unthrifty and yellowish, probably because the pot was poorly drained. Robinson and Johnson stated that abacá will not tolerate a water-logged soil.[6]

On the 282nd day the three plants were apparently healthy but not very vigorous. Obviously the plants had outgrown the pots, as evidenced by the pot-bound roots. Most of the leaves were noticeably green, in contrast with the severely drying leaves of the minus

[5] D. I. Arnon, *Amer. Jour. Bot.*, 25, 322 (1938).
[6] Brittain B. Robinson and Falba L. Johnson, *USDA Monograph*, No. 21 (1953).

magnesium, minus potassium, and, to some extent, the minus calcium plants.

No-nitrogen culture—Forty-two days after treatment, the young leaves were yellow and seemed to have aged very rapidly. Yellowing progressed towards the older leaves. On the 75th day of treatment, all the leaves were yellow and the older ones were drying fast. The two sides of the blade formed a 45-degree angle or less with each other at the midrib, a common sign of lack of moisture. Apparently these plants did not hold much moisture despite the liberal amount maintained in the medium. Figure 1, taken on the 129th day, shows the marked difference in size and appearance between the no-nitrogen and the control plants. On the 282nd day, the plants were small and yellow with five diminutive leaves, but apparently they had struck an equilibrium at this lower plane of nutrition as there was no sign of further retrogression.

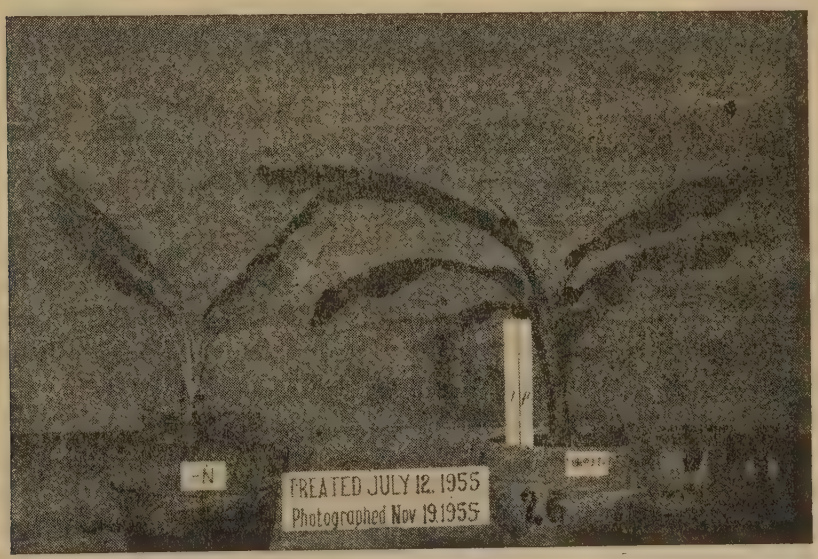

Fig. 1.—No-nitrogen culture beside the control. Note the five small leaves, two of which are drying.

No-phosphate culture—Three plants in this culture were consistently dark green and healthy throughout the experiment. One plant was stunted and had narrow leaves with faint yellow stripes. Indications were that this plant was suffering from a water-logged condition.

Robinson and Johnson cited Peyronnet as stating that plants deprived of phosphate showed no striking exterior symptoms of physiological trouble during the first six months of growth.[7] Nevertheless, all except one died within six months. The plants in this study differed from those of Peyronnet in that they were healthy up to nine months of treatment.

No-sulfate culture—Until the 82nd day of treatment the plants in this culture were dark green and healthy. Some of them seemed more vigorous than plants in the complete culture. The young leaves of these plants retained their yellowish and succulent appearance much longer than the leaves of most of the other plants. The base of the blade was weak and tore easily. On the 129th day the plants were as big as the control. The leaves were mottled green on a yellow background. Yellowing started from the margins and progressed towards the midrib. On the 282nd day only two or three half-dried leaves were on each plant and the pseudostem was weak and rotting. On the 11th month the suckers were yellow like the nitrogen-deficient plants. They were more succulent and were prone to rot during wet weather.

No-potassium culture—The plants were dark green, but the leaves were narrow and seemed unthrifty. On the 129th day the plants were just as big as the control. However, the young leaves tended to have yellow stripes and the old leaves were drying at the margins and tips. On the 282nd day two of the four leaves remaining on the plant were drying. When these plants were transferred to 55-gallon drums for further observation, it was noted that most of the roots were dead or rotting. They easily broke when pulled, suggesting that the fibers were poorly formed. Potassium is considered essential in fiber formation.

Peyronnet found that at the end of six months all his experimental plants were stunted, but the most marked result of deficiency of potassium was a lack of rigidity in the central stem and several nerves of the leaves. The plants were soft and weak and the leaves were flabby. Contrary to this finding, the plants in the present study seemed rigid, dried up, and unthrifty.

No-calcium culture—On the 75th day of treatment, the leaves were dark green, but the old leaves were firing. On the 282nd day, the plants were big and vigorous although some leaves were drying. In contrast Peyronnet observed that the plants without calcium were

[7] *Ibid.*

stunted and the leaves were a deep yellow. None of the plants lived more than three months.

No-magnesium culture—At first the plants were vigorous and big, even bigger than the plants in the complete solution. Later, however, there was a marked tendency for the older leaves to dry up. On the 129th day of treatment the blades of the old leaves were turning yellow between the margin and the midrib. They became orange later and finally dried up. On the 282nd day the plants were still big, but the leaves were drying up fast. Of six remaining leaves, five were dried up or drying.

Peyronnet observed that after three months without magnesium, the plants became chlorotic and the leaves began to droop and die.

No-boron culture—On about the 11th month of treatment, some leaves had stripes of green veins and light green interveinal areas. The light-green areas soon became rust-colored and dry. All the mother plants were still living, unlike in the minus copper culture and some of the other micro-nutrient treatments where the mother plants died. The brown rot attributed to boron deficiency in some succulent plants like sugar beet, turnip, and cauliflower was not observed in abacá.

No-copper culture—During the first seven months of treatment the plants were bigger than those receiving the complete solution. Sometime during the eighth month, however, the pseudostem developed brown to black blotches which progressed to a dry rot. By the 11th month all the mother plants had died and three to five suckers had replaced each of them.

No-iron culture—The plants were big and healthy during the early stages, but on the ninth month of treatment two plants were noticed to have yellow, paper-thin young leaves which dried up soon after emergence. On the 10th month of treatment, three plants showed a mild symptom of mosaic, but this disappeared on the leaves subsequently produced. On the 11th month, all the four plants in the treatment were chlorotic. It was noticed that only one or two suckers in each pot showed iron deficiency. This was hard to understand considering that vascular connection still existed among the different suckers. The occurrence of nonuniform deficiency symptoms was general in all treatments for micro-nutrient deficiency.

No-manganese culture—The generally vigorous plants started to show deficiency symptoms on the 10th month of treatment. The

young leaves were striped yellow and green, with the green stripes fading out towards the margin of the blade.

No-molybdenum culture—On the 11th month many suckers had branched out from the mother plant. Two pots showed mild symptoms of mosaic.

No-zinc culture—On the ninth month, leaves developed brightred to brown areas parallel to the veins. The mother plants which used to be bigger than the control started to dry up, and many vigorous suckers came up.

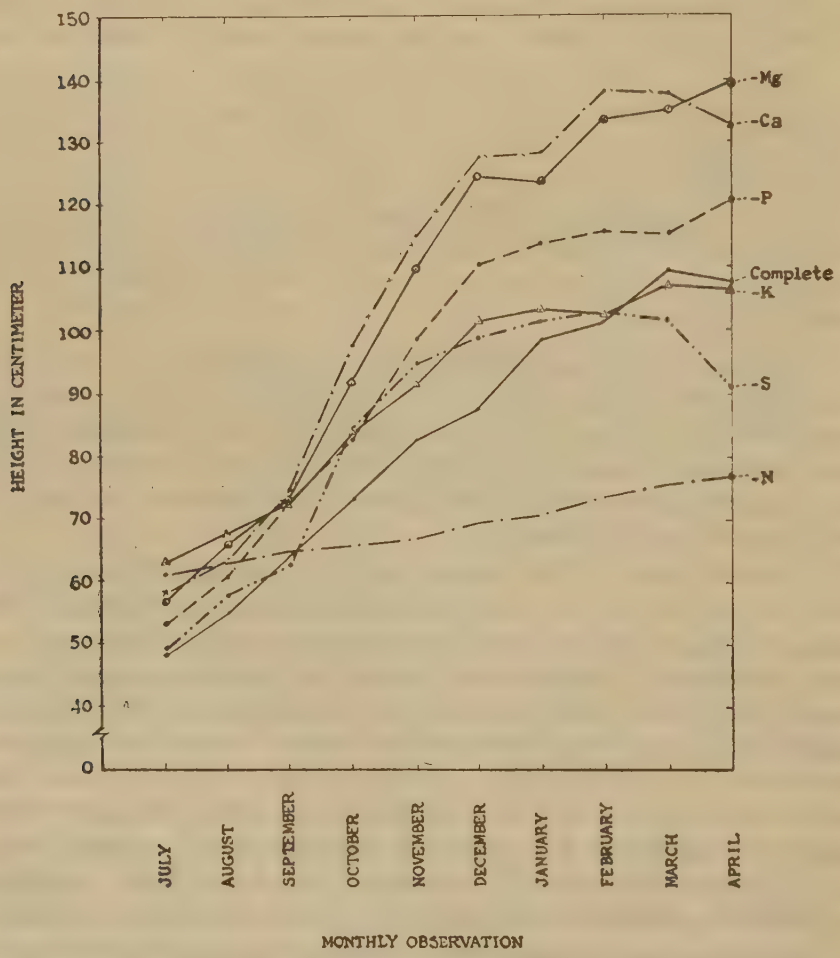

Fig. 2.—Height of plants from the pot to the tip of the longest leaf.

Size of plants. Data on the height from the rim of the pot to the tip of the longest leaf and height of the pseudostem to the angle made by the two youngest leaves were plotted against age. Since the curves were found to be similar, only the height to the tip of the longest leaf is discussed in this report.

The differences among cultures may be considered as random fluctuations up to the third measurement in September. Then the no-nitrogen culture conspicuously lagged behind the others and remained last until April, when the last measurement was made (fig. 2). On the other extreme, the no-calcium and no-magnesium cultures went ahead of the other cultures beginning September and maintained the lead until April. The no-phosphate culture maintained a better trend of growth than the control, but not nearly as good as that of the no-calcium and no-magnesium cultures. The no-sulfate culture was better than the control up to February; thereafter, it became progressively poorer. The general trend of the curves to level off from December to April may have been caused by the dry weather coupled with the limitations imposed by the pot on the roots.

The diameters of the trunks at the rim of the pot plotted against time are shown in figure 3. The control traced a roughly sigmoid curve, with July to September as the period of slow initial growth, September to January the period of most rapid growth, and January to March the period of slow, tending to be negative, growth. The no-calcium and no-magnesium plants, although following the same pattern, attained much bigger diameters. The no-phosphate plants took a middle course between the no-calcium and no-magnesium plants on the one hand and the control on the other, but on the last observation they had decreased markedly in diameter. The no-potassium plants remained almost stationary in stem diameter, whereas the no-sulfate plants maintained a slightly bigger diameter than the control until January, when it started to decrease so rapidly as to almost equal the no-nitrogen plants during the final observation. The no-nitrogen plants showed a gradual general decrease in diameter.

Size and number of leaves. The number of leaves increased from July to October, apparently reflecting the favorable season of growth (fig. 4). The maximum number of leaves was attained from September to December. With the onset of the dry season, the number of leaves gradually decreased. Besides this general trend, there were differences in number of leaves because of treatment. The

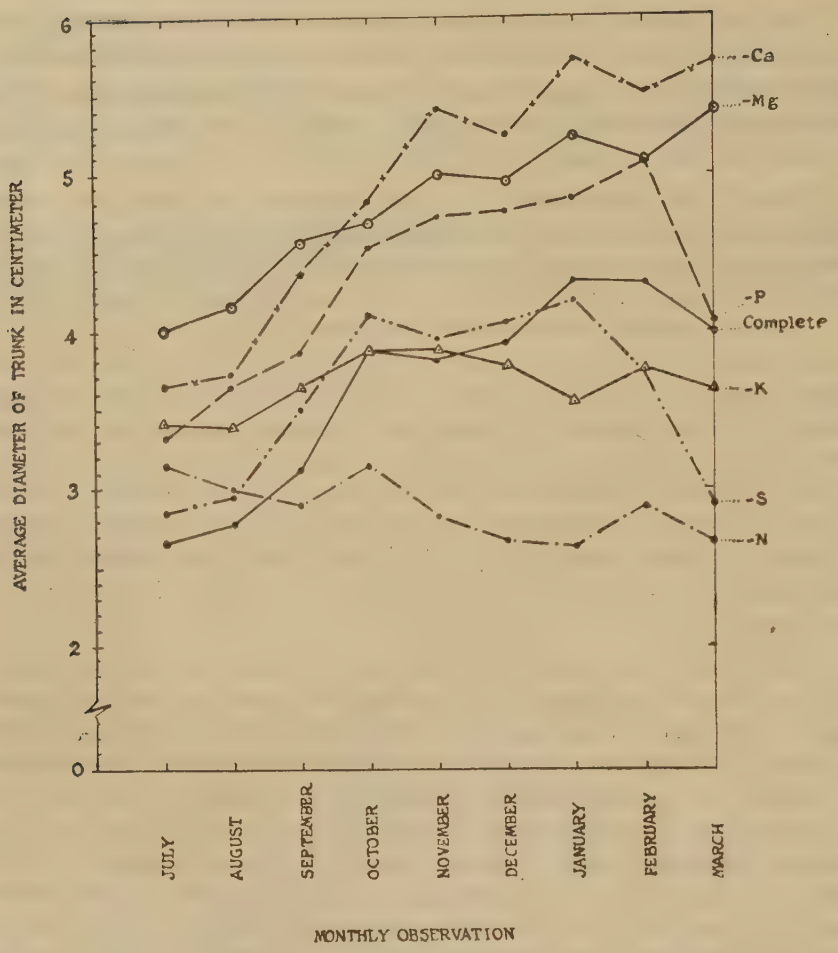

Fig. 3.—Diameter of trunks at the rim of the pot.

no-nitrogen plants had consistently fewer leaves than most of the other plants. At first the no-sulfate plants had about the same number of leaves as the control, but with the coming of the dry season and the debilitating effects of deficiency, they lost their leaves rapidly and came out worse than the no-nitrogen culture. A roughly similar course was shown by the no-potassium plants. The no-calcium and no-magnesium cultures were at first better than the complete culture. However, the no-magnesium plants subsequently lost their leaves very fast.

Leaf area was estimated by multiplying the length by the width at the widest portion. The actual leaf area, found by cutting the

pattern of the leaf on paper and comparing its weight with that of a piece of paper of known area, was an average of 0.692 of the product of the length by the width.

In general, the leaf area reached a maximum from December to February (fig. 5). The decrease in March was probably due to the dry weather which dried the leaves rapidly and decreased leaf formation. The no-phosphate and no-sulfate plants had roughly the same leaf areas as the control except in March when they had conspicuously less. The no-nitrogen plants maintained throughout a fairly even leaf area which was decidedly the lowest of all the cul-

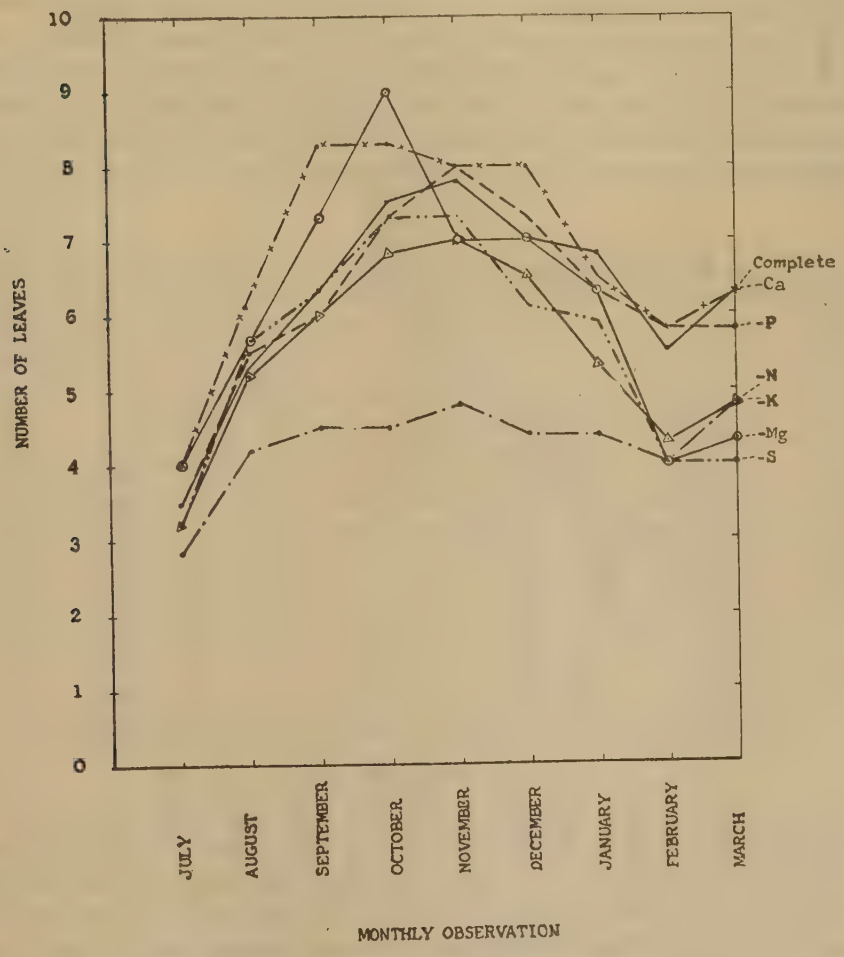

Fig. 4.—Average number of leaves of plants.

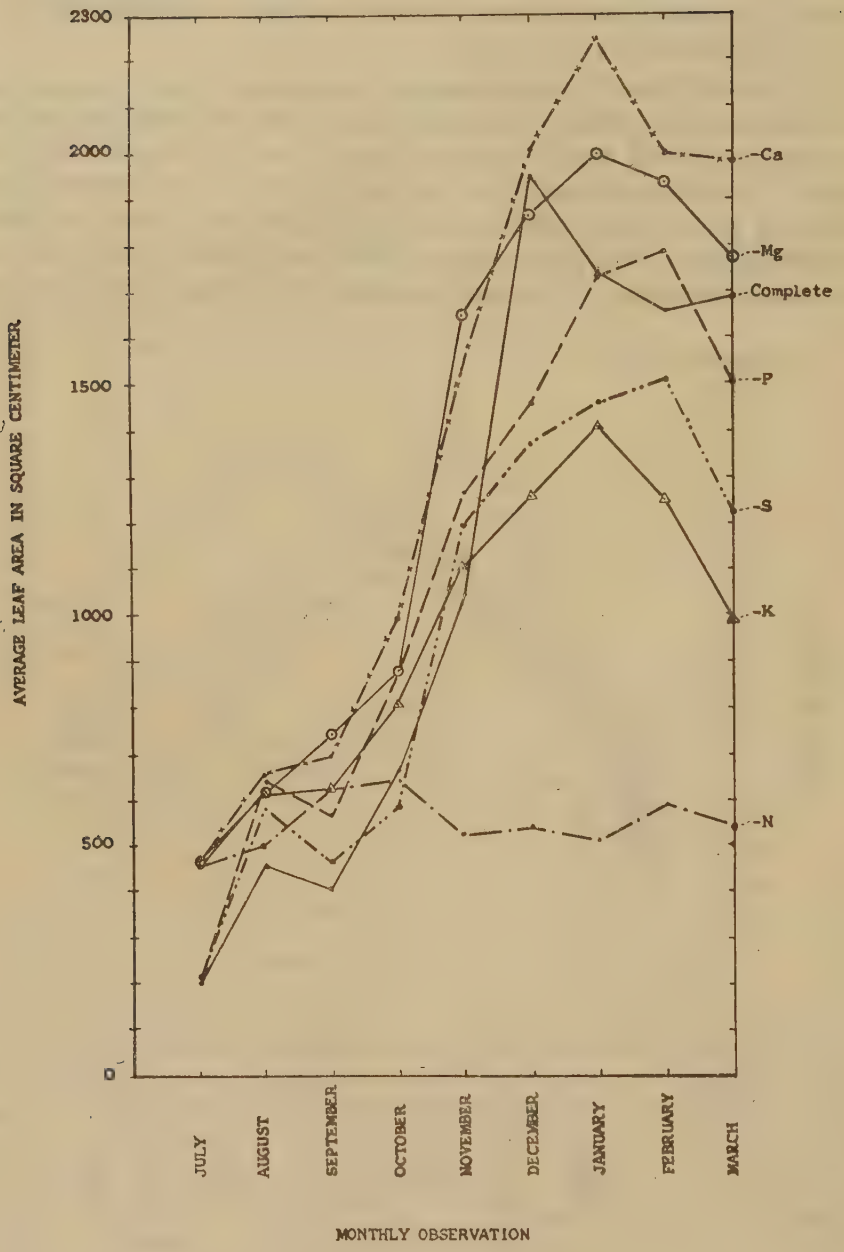

Fig. 5.—Average leaf area of plants.

tures. The leaf areas of no-calcium and no-magnesium plants were consistently bigger than that of the control. In November the leaf area of the no-potassium plants started to lag behind that of the control.

If the observations up to September are disregarded as not reflecting the various treatments as yet and that of April because of the unfavorable dry weather, it will be noted that the state of nutrition had some effect on the general shape of the leaf (table 1). For instance, while the leaves of the control ranged in length from 2.70 to 3.15 times the width, those of the no-nitrogen plants ranged from 3.04 to 3.40 times, and those of the no-phosphate plants from 2.40 to 2.86 times. In other words, nitrogen deficiency tended to reduce growth of the lamina, resulting in a long narrow leaf. The same may be said of potassium deficiency. Limitation of phosphate retarded the growth of the midrib, resulting in a short broad leaf. The dry spell in April caused the plants to produce long narrow leaves.

TABLE 1.—*Average ratio of length to width of the 3rd youngest abacá leaf*

TREATMENT	JULY	AUG.	SEPT.	OCT.	NOV.	DEC.	JAN.	FEB.	MARCH	APRIL
Complete	2.94	2.72	2.61	2.90	2.81	2.70	2.93	3.15	2.80	3.31
—N	3.38	2.93	2.70	3.09	3.12	3.04	3.12	3.40	3.39	2.92
—P	3.60	2.42	2.56	2.86	2.61	2.83	2.40	2.68	2.55	3.35
—S	2.88	2.00	3.06	3.15	2.54	2.82	2.88	2.82	2.96	2.80
—Ca	3.05	2.48	2.36	2.82	2.78	2.63	2.58	2.88	3.08	3.12
—Mg	2.89	2.42	2.54	2.72	2.74	2.71	2.84	2.93	2.96	3.18
—K	3.28	2.65	2.67	2.80	2.60	3.14	2.88	3.28	3.53	3.16
—B	3.18	2.51	2.84	2.87	2.84	2.87	2.97	3.02	3.22	3.31
—Cu	3.06	2.29	2.50	2.89	2.70	2.53	2.88	2.59	2.97	2.88
—Fe	3.18	2.53	3.25	2.24	2.88	3.06	2.82	2.92	2.98	2.96
—Mn	2.89	2.98	2.93	2.55	2.96	2.83	2.71	2.91	3.00	3.15
—Mo	3.11	2.61	3.06	2.68	2.76	2.49	2.85	2.94	3.30	3.00
—Zn	3.26	2.42	2.98	2.48	2.16	2.74	6.73	2.98	3.24	2.86

DISCUSSION

Since the cultures were maintained in the open under a canopy of cheesecloth instead of in a greenhouse, the rains were a disturbing influence. However, the effect may not have been very serious because the condition was not confined to some treatments. It might have masked some of the finer responses of the plants to some treatments, and because of this the differences described might have been

above the fluctuations induced by the changing conditions of the natural environment, and hence of a sizeable magnitude.

The deficiency symptoms, even of the major elements, were not induced with the same ease. While nitrogen-deficiency symptoms appeared after a few weeks of no-nitrogen treatment, definite calcium and phosphate deficiency symptoms could not be induced even after 10 months of treatment. There were also variations in the distinctness of shift from a healthy to a diseased condition. For instance, a plant deficient in magnesium underwent a clear-cut series of changes starting with some yellowish mottling midway between the margin and the midrib and ending with drying of the lamina. On the other hand, a potassium-deficient plant just became gradually unthrifty, hinting at a defective condition somewhere. The differences were probably associated with the function of each element in the activity of the plant.

It seems that symptoms of nitrogen, sulfate, and magnesium deficiencies may be used diagnostically in the field. Symptoms of iron and manganese deficiencies, although distinct, may not be of frequent use in the field because iron and manganese are usually found in sufficient amounts in most soils. Besides, these elements have to be extremely deficient before deficiency symptoms appear. Measurements of the trunk and of the leaves may help in diagnosing potassium deficiency. A slender stem and long, narrow, fairly green leaves characterize a potassium-deficient plant. This condition, however, is about the same as that produced by a lack of water and is apt to be confused with it.

The circumstances of death among the no-copper plants invite some speculation. It is probable that phenol oxidase, a copper enzyme which is active in abacá, has a vital function which can not be assumed by an analogous enzyme like cytochrome oxidase. Because of this, the reduction of copper below a certain threshold concentration caused the almost abrupt death of the plant. The writers hope to explore the situation further.

Although precautions were taken to use only mosaic-free materials, some plants in the minus iron, molybdenum, manganese, magnesium, and calcium cultures showed mosaic symptoms. Three out of four no-iron plants and two out of four no-molybdenum plants showed the symptoms. In these two cultures at least, it is hard to imagine that the symptoms were due to chance infection. It might also be mentioned that in the inoculation studies, plants deficient in the minor elements seemed to catch the disease faster than the plants deficient in the major elements. The observations have stimulated the writers to start other experiments on virus-nutrient relationship.

A PRELIMINARY STUDY OF SOME FACTORS AFFECTING THE MILLING RECOVERY OF RICE IN THE PHILIPPINES [1]

D. L. Umali, M. C. Silverio, and I. S. Santos

The best milling recovery of sun-dried Milfor 6 (2) was obtained at 10 per cent moisture content. Oven-drying at 50°C. was found very satisfactory especially when the rice was milled at 8.5 to 9.0 per cent moisture content. The milled rice dried at 50°C. included more head rice than that dried at 80°C.

Sudden exposure to humid atmosphere of rough rice dried at 70°C. caused some cracking of the grains and breakage at milling. Restoration of grain moisture to 12.3 per cent after drying down to 8.5 per cent at 50°C. was not more advantageous than nonrestoration of moisture.

Methods of drying, moisture content of grains at milling time, and grain size and texture influence the milling recovery and quality of milled rice. These factors were studied to bring out information that can be used in setting up a standard method of processing rice prior to milling. Recovery evaluations of different varieties may then be compared.

The study had three phases: (1) determination of the milling recovery of several varieties of rice; (2) determination of the effect of moisture content and artificial drying on the milling recovery of Milfor 6 (2) variety; and (3) investigation of the efficiency of five commercial rice mills in Los Baños. The first two phases were conducted from April, 1955, to February, 1956, at the Plant Breeding laboratory of the Department of Agronomy.

MATERIALS AND METHODS

Laboratory milling tests. Milfor 6 (2) was used in the experiments on moisture content at milling, air temperature of drying, and moisture restoration. The hulls of the rough rice were removed with the McGill Sheller, the bran layer of the hulled rice with the McGill Miller No. 3. Brewers' rice was separated from the milled rice with aluminum sieves. The bran, hulls, and brewers' rice were separated from each other with the South Dakota Seed Blower.

[1] Central Experiment Station Contribution No. 1892.

About 25 kilograms of Milfor 6 (2) rough rice with a moisture content of 20.7 per cent were sun-dried until the moisture content was down to 12.0 per cent. Three 1,000-gram samples were milled at each of the following moisture contents: 20.0, 18.0, 16.0, 14.2, and 12.0 per cent. As it was difficult to decrease further the moisture content of the rough rice by sun-drying, subsequent drying from 12.0 per cent to 8.5 per cent was done in a Fisher Forced Draft oven (50°C.). Three 1,000-gram samples each were milled at moisture contents of 10.0 and 8.5 per cent.

The rice was artificially dried at air temperatures of 50°C. (122°F.) and 80°C. (176°F.). Although the recommended air temperature for drying does not exceed 130°F., or 54.4°C., the 80°C. temperature was tested to see if temperatures beyond 130°F. may be used in the Philippines.

For the study at 50°C., about 8 kilograms of Milfor 6 (2) with 20.5 per cent moisture were oven-dried to 16.0 per cent. Three 1,000-gram samples each were milled at 18.0 and 16.0 per cent moisture. A 4-kilogram lot with 19.6 per cent moisture was dried to 8.8 per cent moisture. Three 1,000-gram samples each were milled at 14.0 and 10.0 per cent moisture, and two samples at 8.8 per cent. Another 4-kilogram lot with 21.6 per cent moisture was dried to and milled at 12.0 per cent.

For the study at 80°C., a 4-kilogram lot of Milfor 6 (2) with 21.4 per cent moisture was dried to and milled at 18.0 per cent moisture. A lot of about 8 kilograms was dried to 14.0 per cent and milled at 16.0 and 14.0 per cent moisture. A 4-kilogram lot of Milfor 6 (2) with 21.6 per cent moisture was dried to and milled at 12.0 per cent. Another lot of about 8 kilograms with 19.6 per cent moisture was dried to 8.8 per cent moisture and milled at 10.0 and at 8.8 per cent.

Moisture was first restored at an air temperature of 70°C., but when it proved to be somewhat high, another set of experiments was performed at 50°C.

For the study at 70°C., a 4-kilogram lot of Milfor 6 (2) with a moisture content of 14.6 per cent was dried to 8.5 per cent, but its moisture content was restored to 12.0 per cent before milling. Another lot with a moisture content of 15.8 per cent was dried to 8.5 per cent and was milled when the moisture content had been restored to 12.4 per cent.

For the study using 50°C., an 8-kilogram lot of Milfor 6 (2) with a moisture content of 22.7 per cent was dried to 8.5 per cent. Three 1,000-gram samples were milled at 8.5 per cent moisture, and another three when the moisture had been restored to 12.3 per cent.

Milling analysis of some rice varieties. The milling recovery of the following varieties were studied: Azucena, Canoni, Carreon, Guinangang, Luteang, Macapilay-pusa, Magsanaya, Fortuna, Palawan, Malagkit Sunsong, Mangasa, Peta, Sinaguing, and Sinantonio. All these varieties were of the nonglutinous type, except Macapilay-pusa and Malagkit Sunsong. Their moisture contents were reduced to about 10 to 13 per cent by sun-drying.

These varieties had been in storage for a year. Canoni, Magsanaya, and Macapilay-pusa were stored with DDT powder. The weevil-damaged grains of Peta and Sinantonio could not be removed even with the use of the blower as the live weevils made them as heavy as the undamaged grains.

Study of Los Baños rice mills. The efficiency of five rice mills of the *kiskisan* type was studied. Three 1/3-cavan samples (14.67 kilograms) of Seraup Kechil 36 and three 1/2-cavan samples (22 kilograms) of Wagwag were milled in each of the five rice mills.

RESULTS AND DISCUSSION

Definition of terms. Results of laboratory milling tests in this study give mill yield in terms of "commercial rice," which refers to total clean rice without the brewers' rice.

"Discrepancy" indicates the differences, whether in actual units or in percentages, between the weight of rough rice and the total weight of the different milling constituents analyzed. Milling constituents in this study include commercial rice, brewers' rice, bran, and hulls.

Discrepancy is preceded by a positive sign if the weight of rough rice is more than the total weight of the milling constituents, and by a negative sign if less. Assuming that all weighings are accurate, positive discrepancy may be due to loss of bran, hulls, brewers' rice, commercial rice and/or to loss of moisture during the removal of the bran layer, whereas negative discrepancy is most likely due to moisture absorption in excess of moisture loss during milling.

"Bran" includes the seed coat or bran layer (genuine bran) plus a few very small particles of brewers' rice and broken pieces of hulls.

Effect of moisture content at milling. Milfor 6 (2) was harvested when the moisture content of the grain was 20.7 per cent. This was in agreement with recommendations from the United States.[2, 3]

Commercial rice yields were distinctly lower at 20.0 and 18.0 per cent moisture than at lower moisture contents (table 1). The progressively decreasing discrepancies from the higher moisture contents to the lower ones may explain the differences; the discrepancies were less in rice milled at lower moisture contents. During milling, moisture is lost because of the heating up of the chamber in which hulled rice is freed of the bran layer. However, even if the values of discrepancy are algebraically added to the percentages of commercial rice, millings at 16 per cent moisture or lower would still give higher commercial rice yields. If corrections for discrepancies are made, milling at 10.0 per cent moisture would give the highest numerical commercial rice yield, 65.5 per cent. To a certain extent also, the higher percentages of brewers' rice in millings at 20.0 and at 18.0 per cent moisture may explain the low commercial rice yields at those millings. That the percentage of brewers' rice at 18.0 per cent moisture was not as high as it should have been could have been because some of it was not separated from the bran and the hulls. The percentages of hulls and bran were highest at 18.0 per cent moisture.

At least a portion of the negative discrepancies at the lower moisture contents (10.0 and 8.5 per cent) was due to moisture ab-

TABLE 1.—*Milling yield in per cent of Milfor 6 (2) with varying moisture contents at milling*

MOISTURE AT MILLING	MILLING CONSTITUENT				
	Commercial rice	Brewers' rice	Bran	Hulls	Discrepancy
20.0	55.1 ± 1.8	9.5	7.5	21.1	+ 6.6
18.0	56.1 ± 0.5	5.9	9.8	23.6	+ 4.6
16.0	62.7 ± 0.3	4.7	8.7	21.8	+ 2.1
14.2	63.7 ± 0.2	4.8	8.7	21.7	+ 1.1
12.0	64.0 ± 0.6	5.1	8.9	22.0	0.0
10.0 [a]	66.5 ± 0.4	4.0	8.1	22.4	− 1.0
8.5 [a]	64.1 ± 0.2	6.0	8.0	22.5	− 0.6

[a] Sun-dried to 12.0 per cent and then oven-dried.

[2] Anonymous, *Southern Cooperative Series Bull.*, 29, 5 (1953).
[3] L. L. Davis, *California Agric. Ext. Serv. Cir.*, 163 (1950).

sorption. Rough rice at 10.0 per cent moisture or lower could absorb moisture from the atmosphere. The moisture absorption can be reduced to a minimum if the milling constituents are placed in moisture-proof containers immediately after milling. At higher moisture contents, the rice lose considerable moisture because of the heat generated during removal of the bran layer.

To correct for the downward bias based on the discrepancy would not be entirely valid since the different parts of the grain (endosperm, bran, and hull) lose moisture at different rates. Also, it has to be assumed that positive discrepancy arising from spillings is negligible and equally distributed among the different constituents. If the moisture content of the milled rice can be determined accurately and mill yields from millings at different moisture contents transformed to a comparable moisture basis, the problem might possibly be solved. The use of an equal weight of rough rice sample based on the maximum moisture content should also be considered.

The standard errors indicate the degree of variability of the results. However, practical problems involved, like discrepancies due to moisture absorption and moisture evaporation, preclude statistical interpretation of the data.

Effect of temperature of drying. Millings at 18.0 per cent moisture content of rough rice dried at 50° and 80°C. resulted again in high positive discrepancies (table 2). Except that at 18.0 per cent moisture, rough rice of Milfor 6 (2) dried at 50°C. gave higher yields of commercial rice and lower yields of brewers' rice than that dried at 80°C. Since algebraic differences between discrepancies were small, the low yield of commercial rice was obviously associated with the high percentage of brewers' rice. From 14.0 per cent moisture content down to 8.8 per cent, drying at 80°C. resulted in commercial rice with plenty of second heads and screenings; at 50°C., commercial rice was composed chiefly of head rice.

The recommended air temperature for drying rough rice is not more than 54.4°C.[4] Walker reported that continuous drying at 80°C. resulted in too rapid drying and subsequent cracking of grains.[5]

The yield of commercial rice dried at 80°C. and milled at 18.0 per cent moisture was probably higher than should be expected for rough rice dried continuously. A sample of rough rice with 18.0

[4] Anonymous, *Louisiana Bull.*, 416, 3 (1947).
[5] R. F. Walker (compiler), "Rice," Louisiana State Dept. Agric. and Immigration, 1952.

TABLE 2.—*Milling yield of Milfor 6 (2) dried at 50° and 80°C. and with different moisture contents*

MOISTURE		AIR TEMPERATURE	MILLING CONSTITUENT				
Soon after harvest	At milling		Commercial rice	Brewers' rice	Bran	Hulls	Discrepancy
%	%	°C.	%	%	%	%	%
20.5	18.0	50	55.9 ± 0.4	7.2	9.7	21.2	+ 6.0
21.4	18.0	80	58.8 ± 0.2	6.3	8.7	21.3	+ 4.9
18.8	16.0 [a]	50	64.1 ± 0.8	4.6	9.6	22.0	− 0.3
19.8	16.0	80	55.5 ± 0.7	12.4	8.6	22.1	+ 1.4
19.6	14.0	50	62.3 ± 0.6	6.8	9.6	22.3	− 1.0
19.8	14.0	80	60.3 ± 0.3 [b]	9.1	8.4	20.7	+ 1.5
21.6	12.0	50	63.3 ± 0.2	4.6	9.8	21.5	+ 0.8
21.6	12.0	80	56.4 ± 0.7	12.4	9.0	21.4	+ 0.8
19.6	10.0	50	64.6 ± 0.6	4.7	9.0	20.9	+ 0.8
19.6	10.0	80	60.7 ± 0.4 [b]	9.5	8.8	21.2	− 0.2
19.6	8.8 [a]	50	70.0 ± 0.2	1.7	8.5	21.4	− 1.6
19.6	8.8	80	60.1 ± 0.4	12.0	8.2	21.6	− 1.9

[a] Two trials only. The rest had three trials.
[b] Plenty of second heads and screenings.

per cent moisture was oven-dried at 80°C. for five hours and then allowed unintentionally to stay in the oven without heat for two days. Heat was later restored until the desired moisture content was reached. What actually resulted then was intermittent drying or tempering which could have been responsible for the high yield of commercial rice.[6, 7, 8]

Some grains of the rice milled at 18 per cent moisture and dried at 80°C. were slightly brown. In the rest of the treatments at 80°C., stirring of the rough rice prevented drying or burning of the grains.

The amount of bran recovered was consistently less at 80°C. than at 50°C., probably because of the rapid desiccation of the bran layer at the higher temperature.

Effect of moisture restoration. Two sets of millings were done at an air temperature of 70°C. for drying. In the first set, the rough rice was exposed to the humid atmosphere immediately after the desired lowest moisture content had been reached in the evening. In the second set, the desired lowest moisture content was reached in the morning. The oven was turned off, but the rough rice was not brought out of the oven and exposed to the humid atmosphere till

[6] F. D. Maramba, *Philippine Agric. Engineer. Jour.*, 4, 71; 126 (1953).
[7] Walker, *op. cit.*
[8] Davis, *op. cit.*

the following evening. The sudden exposure to the cold humid atmosphere in the first case might explain the low percentage of commercial rice and high percentage of brewers' rice (table 3).

TABLE 3.—*Effect of moisture restoration on the milling recovery of Milfor 6 (2)*

TEMPERATURE	MOISTURE			MILLING CONSTITUENT				
	Initial	After drying	At milling	Commercial rice	Brewers' rice	Bran	Hull	Discrepancy
	%	%	%	%	%	%	%	%
70°C.	14.6	8.5	12.0	57.4 ± 1.2 [a]	13.5	9.7	20.9	− 1.5
70°C.	15.8	8.5	12.4	64.1 ± 0.2 [a]	4.8	10.0	20.5	0.6
50°C.	22.7	8.5	8.5	69.9 ± 0.3	1.2	8.6	20.0	0.3
50°C.	22.7	8.5	12.3	67.5 ± 0.2	1.9	9.7	19.6	1.3

[a] Plenty of second heads and screenings.

Two sets of millings were also done for the study on rice dried at 50°C. In one set, the milling was done at the lowest moisture content reached. In the other set, the rough rice was exposed to the humid atmosphere until moisture was restored to 12.3 per cent before milling. There seemed to be some slight advantage in commercial rice yield in favor of no restoration. This should be confirmed in further studies.

There is a common belief among housewives that rough rice dried in the sun should not be milled immediately for best results. However, these tests showed that it is difficult to bring down the moisture content of rough rice to about 8.5 per cent by sun-drying alone. Future studies on moisture restoration should probably make use of a minimum moisture content of 11 per cent.

Milling analysis of some rice varieties. The milling analysis of the different varieties is given in table 4. Percentages of commercial rice varied from 45.5 (Mangasa) to 68.9 (Malagkit Sunsong); those of brewers' rice varied from 2.4 (Malagkit Sunsong) to 25.9 (Mangasa). The commercial rice of Mangasa was composed totally of second heads and screenings. Its chalky nature plus the severe damage from weevils might have been responsible for this. The percentage of hulls of Guinangang (25.2) seemed abnormally high. Discrepancies were small.

No attempt was made to relate commercial rice yield to grain shape and texture. Grain dimensions and, most probably, shape, are conceivably affected by environmental conditions such as climate and soil. The use of field replications should be a part of a more

TABLE 4.—*Milling analysis of some rice varieties*

VARIETY	CHARACTERISTIC OF THE GRAIN				MOISTURE CONTENT	MILLING CONSTITUENT					REMARKS
	Length	Thickness	Shape	Texture		Commercial rice	Brewers' rice	Bran	Hulls	Discrepancy	
	mm.	*mm.*			%	%	%	%	%	%	
Azucena	7.28 ± 0.09	1.85 ± 0.22	long	flinty	12.6	60.8 ± 0.7	8.4	8.0	21.7	1.1	Rotten because of improper storage
Fortuna	6.85 ± 0.07	1.29 ± 0.12	long	flinty	12.0	65.2 ± 0.1	3.4	8.7	21.6	1.1	Damaged by weevils and worms but less so than Mangasa.
Magsanaya	6.38 ± 0.10	1.82 ± 0.17	medium	medium chalky	12.2	64.1 ± 0.1	6.7	9.5	19.3	0.4	
Luteang	6.37 ± 0.58	2.00 ± 0.25	medium	chalky	12.5	66.4 ± 0.3	3.2	10.5	18.5	1.4	
Macapilay-pusa	6.23 ± 0.19	1.53 ± 0.17	medium	waxy	12.4	56.9 ± 0.6	10.2	10.6	22.0	0.3	
Peta	6.23 ± 0.21	1.76 ± 0.28	medium	flinty	12.2	62.7 ± 0.8	5.2	5.2	22.6	0.8	Severely attacked by worms and damaged by weevils.
Canoni	6.10 ± 0.74	1.80 ± 0.15	medium	medium chalky	12.4	59.5 ± 0.9	10.2	9.4	20.2	0.7	
Guinangang	5.88 ± 0.72	1.72 ± 0.22	medium	medium chalky	12.0	63.8 ± 0.3	4.5	8.4	25.2	—1.9	
Sinantonio	5.88 ± 0.57	1.76 ± 0.17	medium	flinty	12.8	60.4 ± 0.6	5.7	10.1	22.9	0.9	
Sinaguing	5.56 ± 0.31	1.98 ± 0.30	short	chalky	12.2	62.1 ± 0.1	6.1	10.6	21.1	0.1	
Palawan	5.55 ± 0.18	1.80 ± 0.21	short	flinty	12.6	64.4 ± 0.2	7.1	9.2	19.2	0.1	
Mangasa	5.31 ± 0.23	1.80 ± 0.25	short	chalky	12.0	45.5 ± 0.4	25.9	8.5	21.1	—1.0	Severely damaged by weevils.
Malagkit Sunsong	5.26 ± 0.06	2.03 ± 0.00	short	waxy	10.4	68.9 ± 0.2	2.4	9.0	21.1	1.4	
Carreon	5.07 ± 0.37	1.97 ± 0.06	short	chalky	12.0	65.6 ± 0.4	3.8	9.6	21.3	—0.3	

intensive study on the relation of mill yield to grain shape and texture.

Milling efficiency of rice mills in Los Baños. Mill yield is expressed in table 5 in terms of total clean rice because the *kiskisan* type of rice mill does not separate brewers' rice. Positive discrepancies included loss of some milled rice left inside the machine and spilled during the milling process. The lone negative discrepancy could have been due to some residual rice left in the machine and added to the milled rice of the experiment.

TABLE 5.—*Milling efficiency of five kiskisan rice mills*

VARIETY	RICE MILL NO.	MILLING CONSTITUENT					
		Total clean rice		Bran and hulls		Discrepancy	
		Actual	Per cent	Actual	Per cent	Actual	Per cent
		kg.		*kg.*		*kg.*	
Seraup Kechil 36 [a]	I	9.74	66.4 ± 0.2	4.66	31.8	0.26	1.8
	II	8.71	59.4 ± 0.5	5.43	37.1	0.52	3.5
	III	9.12	62.2 ± 0.0	5.00	34.1	0.54	3.9
	IV	9.02	61.6 ± 3.7	4.61	31.5	1.01	6.9
	V	9.42	64.2 ± 4.4	4.22	28.8	1.03	7.0
Mean		9.20	62.8 ± 1.2	4.79	32.6	0.67	4.6
Wagwag [b]	I	8.46	58.9 ± 2.2	5.56	38.7	0.34	2.4
	II	13.49	61.3 ± 0.1	8.25	37.5	0.25	1.1
	III	13.52	61.4 ± 0.3	8.07	36.7	0.41	1.9
	IV	13.60	61.8 ± 2.0	7.81	35.5	0.50	2.3
	V	13.38	60.8 ± 1.2	8.64	39.3	0.02	—0.9
Mean		12.49	60.9 ± 0.6	7.67	37.5	0.30	1.5
Grand mean			61.8 ± 0.7		35.1		3.1

[a] Based on 14.67 kg.
[b] Based on 22 kg.
t, S.K. 36 vs. Wagwag = 2.02, n.s.

Based on Seraup Kechil 36 and Wagwag, the milling recovery of the five Los Baños rice mills averaged about 62 per cent. A *t*-test between the means of Seraup Kechil 36 and Wagwag indicated no significant difference in yield of total clean rice. Percentages for Seraup Kechil 36 were more variable probably because of the smaller sample size used.

In laboratory milling tests, the mean yield of total clean rice (commercial rice plus brewers' rice) should fall between 66 and 70 per cent.

THE DIGESTIBILITY BY SWINE OF SWEET POTATO VINES AND TUBERS, CASSAVA ROOTS, AND GREEN PAPAYA FRUITS [1]

JOSE J. ZARATE

There were no significant differences between breeds in digestion coefficients for organic matter, fat, and crude protein in sweet potato tubers and vines, cassava roots, and green papaya fruits. Philippine pigs gave the highest digestion coefficients for fiber and nitrogen-free extract in sweet potato vine.

Chemical analysis represents the starting point in determining the nutritive value of feeds, but the actual value of the nutrients depends upon their digestibility. Variations in the structure of the digestive system of the different species of animals are responsible for the differences in the utilization of various feeds.

In the Philippines vines and cull tubers of sweet potato (*Ipomea batatas* Linn., Poir.), cooked roots of cassava (*Manihot utilissima* Pohl.), and at times green fruits of papaya (*Carica papaya* Linn.) are fed to swine, but data on their digestible nutrients have not been obtained. The different digestion coefficients of the nutrients in these feeds were estimated in the Department of Animal Husbandry from February to September, 1954, and the digestive efficiency of the Philippine, Berkjala, and Berkshire pigs regarding these nutrients was studied.

MATERIALS AND METHODS

Two weanlings each of the Berkshire, Philippine, and Berkjala breeds were placed in individual metabolism cages. The ages of the animals ranged from four to five months, and the initial weights varied from 7.2 to 13.4 kilograms.

During a preliminary period of five days the pigs were fed once daily, in the morning, with the College standard ration No. 2. Then they were given the test feeds according to the schedule in table 1.

The papaya fruits were sliced into small pieces to facilitate analysis and to give a consistent proportion of skin, pulp, and seeds to

[1] Central Experiment Station Contribution No. 1893. Thesis presented for graduation, October, 1955, with the degree of Bachelor of Science in Agriculture from the College of Agriculture. Prepared in the Department of Animal Husbandry under the direction of Dr. J. K. Loosli and Dr. Valente Villegas.

TABLE 1.—*Schedule of feeding*

PERIOD	ANIMAL NUMBER		
	1761	3	1713
I	P	S	C
II	C	S	P
III	C	P	S
IV	CV	CV	CV

PERIOD	ANIMAL NUMBER		
	1871	1814	35
I	C	P	S
II	P	S	C
III	S	C	P
IV	CV	CV	CV

P—Green papaya fruits
S—Sweet potato vines
C—Cassava roots
CV—Sweet potato tubers

1761 and 1814—Berkjala pigs
3 and 35—Berkshire pigs
1713 and 1871—Philippine pigs

the feed. The cassava roots were chopped and dried thoroughly to destroy the hydrocyanic acid. The sweet potato vines were fed to the pigs without chopping. The sweet potato tubers were sliced and fed raw. These feeds were given exclusively with some salt and shells. Each ration was given for eight days to eliminate as much as possible the effect of the previous ration.

The daily feed allowance was kept constant although slight variations did occur. Larger amounts of papaya were fed to animal No. 1761 when no feces were voided for three consecutive days in the first trial.

The weight of each animal was taken at the beginning of each collection period and at the end seven days after. The fresh and dry weights of the feces were determined daily. Twenty-five to 100 per cent of the fresh feces was dried quickly under the infrared lamp and composited in sealed Mason jars until analyzed by the AOAC method.

During the preliminary period, animal No. 1713 was found to be suffering from parasitism. This animal was treated with sodium flouride. The other animals were also given the same medicine to eliminate any possibility of parasitism. Later, pig No. 1713 died

of hydrocyanic poisoning. It was immediately replaced by another animal and the study was resumed using sun-dried cassava tubers.

RESULTS AND DISCUSSION

Sweet potato tubers had a mean digestion coefficient of 91.8 per cent for organic matter (table 2). Between breeds, however, the digestion coefficients did not vary significantly. Sweet potato vines showed the lowest digestibility because of their fibrous constituents. The highest digestion coefficient of 95.9 per cent for organic matter

TABLE 2.—*Digestion coefficients in per cent for sweet potato vines, sweet potato tubers, cassava roots, and green papaya fruits*

ANIMAL NUMBER	DIGESTION COEFFICIENTS				
	O.M.	Protein	Fat	Fiber	NFE
Sweet potato tubers					
Philippine, 1713	90.1	10.3	76.8	–11.8	95.5
Berkjala, 1761	91.6	16.7	81.6	16.6	95.9
Berkshire, 3	91.9	–4.5	86.5	49.7	96.5
Philippine, 1871	93.8	26.5	76.2	52.1	97.3
Berkjala, 1814	92.2	91.2	66.7	60.9	93.8
Berkshire, 35	91.2	23.2	71.4	0	96.5
Mean	91.8	—	76.5	—	95.9
Sweet potato vines					
Philippine, 1713	81.1	73.0	50.0	82.7	86.9
Berkjala, 1761	85.7	67.6	51.0	13.9	70.5
Berkshire, 3	79.3	64.0	70.2	79.4	85.1
Philippine, 1871	87.1	65.3	75.4	89.6	90.2
Berkjala, 1814	45.3	14.8	22.2	27.3	65.1
Berkshire, 35	70.8	52.9	–10.7	47.3	84.1
Mean	74.8	56.2	—	56.7	80.3
Cassava roots					
Philippine, 1713	94.0	28.6	78.3	87.0	97.8
Berkjala, 1761	95.6	49.5	82.5	45.1	98.2
Berkshire, 3	97.0	59.8	82.9	76.4	98.8
Philippine, 1871	97.4	24.2	71.4	61.9	92.1
Berkjala, 1814	94.7	–55.9	76.6	51.8	97.4
Berkshire, 35	97.1	45.2	71.7	66.1	98.9
Mean	95.9	—	77.2	64.7	97.2
Green papaya fruits					
Philippine, 1713	86.8	88.5	63.6	78.4	91.4
Berkjala, 1761	82.4	53.3	14.3	82.0	89.4
Berkshire, 3	90.3	65.2	44.4	93.5	93.8
Philippine, 1871	82.1	65.7	46.2	77.2	88.5
Berkjala, 1814	91.9	86.4	82.1	92.6	94.1
Berkshire, 35	94.7	94.3	84.0	89.1	96.6
Mean	88.0	75.5	55.7	85.4	92.3

was obtained from cassava roots. Feeds that are high in fiber are less digestible and therefore less nutritious than those low in fiber.

Morrison states that sweet potatoes can replace one-half to two-thirds of the grain allowance.[2] He further states that all roots and tubers are very watery and low in dry matter, but the dry matter they contain is of high quality, being low in fiber, highly digestible, and high in net energy value per kilo.

Berkjala and Philippine pigs differed greatly in their ability to digest organic matter in sweet potato vines. The other nutrients in the vine were equally digestible to the different breeds.

Green papaya fruits contained the most protein, followed by sweet potato vines (table 3). Some negative results were obtained because of the low protein content of the feeds and the small amount of feed given to the animals. The negative value for protein in

TABLE 3.—*Chemical analysis in per cent of the feeds as fed*

FEED	SAMPLE NO.	MOISTURE	PROTEIN	FAT	FIBER	NFE	ASH
	186	73.3	0.9	0.8	0.6	33.2	1.2
	258	15.8	2.5	1.4	1.3	76.1	2.9
	342	18.1	1.6	1.5	1.8	74.7	2.7
Cassava roots	350	60.2	0.6	0.2	0.9	36.5	1.6
	380	33.1	0.6	0.8	1.5	61.9	2.5
	327	18.4	1.2	1.5	1.8	74.3	2.8
Mean		36.5	1.3	1.0	1.3	59.4	2.2
	185	22.9	3.7	1.2	5.8	13.3	3.2
	300	80.5	1.5	0.8	3.4	12.1	1.6
Sweet potato	256	80.4	2.7	0.7	3.2	11.0	2.0
vines	325	88.4	1.1	0.5	2.2	6.5	1.1
	351	77.2	3.4	0.9	4.4	11.2	2.9
	379	75.1	2.1	0.8	5.7	13.3	3.0
Mean		70.6	2.4	0.8	4.1	11.3	2.3
	187	89.9	1.0	0.2	1.3	6.7	0.8
	303	92.8	0.9	0.2	1.1	4.3	0.7
Green papaya	260	92.6	0.7	0.1	0.9	5.1	0.6
fruits	326	92.6	0.9	0.2	1.0	4.7	0.6
	352	71.8	3.5	0.7	5.0	16.4	2.6
	381	33.6	8.6	1.2	10.5	39.4	6.8
Mean		78.9	2.6	0.4	3.3	12.8	2.0
Sweet potato	362	66.4	0.8	0.7	0.9	30.1	1.2
tubers	469	70.8	0.7	0.4	0.9	25.9	1.3
Mean		68.6	0.8	0.6	0.9	28.0	1.3

[2] F. B. Morrison, "Feeds and Feeding," Morrison Publishing Co., Ithaca, N. Y., 1951.

sweet potato tubers was −4.5 per cent for Berkshire pig No. 3, and for protein in cassava roots, −55.9 per cent for Berkjala pig No. 1814 (table 2).

According to Morrison, sweet potato tubers have an average composition of 1.6 per cent protein, 0.4 per cent fat, 1.9 per cent fiber, and 26.4 per cent nitrogen-free extract. The data in the present study show higher percentages of nutrients (table 3).

Of all the animals, Berkshire pig No. 3 had the highest digestion coefficient for fat in sweet potato tubers (table 2). Chemical analysis on the fresh basis showed that the mean value for fat was only .95 per cent.

Sweet potato vines had the lowest digestion coefficient because of fiber content (table 4). Chemical analysis on the fresh basis showed that the vines had 4.1 per cent crude fiber (table 3), whereas Morrison obtained 19.1 per cent crude fiber from sweet potato vines on the air-dry basis.

TABLE 4.—*Digestion coefficient for fiber in sweet potato vines*

ANIMALS	REP. 1	REP. 2	TOTAL	MEAN
Philippine	82.7	89.6	172.3	86.1
Berkjala	13.9	27.3	41.2	20.6
Berkshire	79.4	47.3	126.7	63.3
Total	176.0	164.2	340.2	

SMD 5%—46.1

The Philippine, Berkjala, and Berkshire pigs had slight differences in digestion coefficient for organic matter of sweet potato tubers in replication 1, period I. Similar results were obtained in the second replication. It is evident that the breed of the animal did not influence the digestibility of the feed.

Chemical analysis of the feeds showed that cassava tubers gave an average of 36.5 per cent moisture, 1.3 per cent protein, 1.0 per cent fat, 1.3 per cent crude fiber, and 59.4 per cent nitrogen-free extract (table 3).

Of all the feeds analyzed fresh green papaya fruits had the highest value for moisture, and cassava roots had the lowest.

The digestion coefficients for nitrogen-free extract in sweet potato vines were markedly different among the breeds on both the 5 and 1 per cent levels (table 5).

TABLE 5.— *Digestion coefficient for nitrogen-free extract in sweet potato vines*

ANIMALS	REP. 1	REP. 2	TOTAL	MEAN
Philippine	86.9	90.2	177.1	88.5
Berkjala	70.5	65.1	135.6	67.8
Berkshire	85.1	84.1	169.2	84.6
Total	242.5	239.4	481.9	

SMD 5%—8.3
1%—12.4

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If liberal arts graduates need more general knowledge of science and technology, certainly scientists and engineers need more breadth.

—*Thomas K. Sherwood*

ORGANIC INSECTICIDES IN THE CONTROL OF CITRUS RIND BORER [1]

G. B. Viado, S. M. Cendaña, and C. T. Rivera [2]

Endrin gave the best control of citrus rind borer on Szinkom mandarin; systox was next best. Fruits picked from the trees had higher percentages of infestation than dropped fruits. Only a small percentage of dropped fruits was attacked by rind borer, indicating that other factors besides rind borer injury are responsible for fruit drop. On Siamese pummelo EPN gave the best control, closely followed by endrin.

Premature fruit drop in citrus orchards in the Philippines is largely attributed by the growers to damage by the citrus rind borer, *Prays endocarpa* Moore. The insect also produces unsightly galls or swellings on the rind of mature fruits.

Investigations conducted in this country before the last war point to arsenical insecticides as the only means of effecting a rather limited control of the insect. San Juan reported that oil emulsion was effective in killing the pupa of the borer.[3]

Many of the new organic synthetic insecticides are effective against many lepidopterous and homopterous pests of various crops. Several of them were tested for their value in the control of citrus insects from May to September, 1955, in the Dimayuga citrus farm in Lipa City, Batangas, and from August, 1955, to January, 1956, in a pummelo orchard in Calauan, Laguna.

EXPERIMENT I: EFFECTS ON THE BORER ON SZINKOM MANDARIN OF SYSTOX, PARATHION, ENDRIN, DDT + MOLASSES, AND DIELDRIN

Materials and methods. This experiment was conducted in the Dimayuga farm. The insecticides tested and their proportions per 100 gallons of water follow:

DDT, a 25% wettable powder	2 pounds
DDT + molasses	1 quart
Parathion, a 2% wettable powder	2 pounds
Systox, an emulsifiable concentrate	½ pint
Dieldrin, a 15% wettable powder	1 pound
Endrin, a 19.5% emulsifiable concentrate	1 pint

[1] Central Experiment Station Contribution No. 1894.

[2] The authors acknowledge the help given by Dr. J. G. Matthysse, former Visiting Professor of Entomology, in planning and conducting this research project.

[3] J. M. San Juan, *Philippine Agriculturist*, 12, 339 (1924).

The sprays were applied at a pressure of 150 to 200 pounds per square inch with a single nozzle spray gun. An average of 2 gallons was sprayed on each tree.

Four complete randomized blocks were used, each block consisting of seven plots of two trees each. The trees sprayed were about 25 years old and were bearing heavily. The spraying schedule covered the blooming period and the development of the fruits. The first spraying was done on May 18, 1955, before the flowers opened. Subsequent sprayings were done on May 27, June 7, June 23, July 20, and September 20, 1955.

Results and discussion. In the first observation (July 6), 960 fruits from each treatment were dissected for the number of larvae in each fruit. In each of the second and fourth observations (July 20 and September 14), 300 dropped fruits collected at random from each treatment were dissected to determine the proportion of dropped fruits attacked by rind borer. The third (August 3) and fifth (October 2) observations were each based on 640 fruits picked from the trees.

In each of the five observations endrin was the best, followed by systox (table 1). In the first observation, not a single fruit in the plots treated with endrin was attacked by rind borer. The incidence of infestation in the control was high; however, the mean differences between treatments were insignificant, pointing to a high degree of variability among replications. In the second observation significance at 5 per cent level was noted. The remaining observa-

TABLE 1.—*Percentage of Szinkom mandarin attacked by rind borer in plots sprayed with five organic insecticides*

INSECTICIDE	DATE OBSERVED 1955					MEAN
	July 6	July 20	Aug. 3	Sept. 14	Oct. 2	
Systox	1.06	1.48	1.15	1.36	1.95	1.40
Parathion	4.33	7.15	4.30	2.75	3.38	4.38
Endrin	0	.67	.56	.66	.58	.49
DDT + molasses	4.85	3.22	3.97	6.16	7.42	5.12
DDT	3.22	5.51	6.35	5.34	2.05	4.49
Dieldrin	4.40	6.46	6.97	6.84	5.14	5.96
Check	10.39	7.59	13.14	8.95	11.40	10.29
SMD (T) at 5%	[a]	5.81	3.91	4.01	4.56	
SMD (T) at 1%	[a]	[a]	5.35	5.49	6.24	

[a] Insignificant.

tions showed significance at both levels. Fruits picked from the trees gave higher percentages of infestation than those collected from the ground.

EXPERIMENT 2: EFFECTS ON THE BORER ON SIAMESE PUMMELO OF SYSTOX, DDD, METHOXYCHLOR, ENDRIN, AND EPN

Materials and methods. Old bearing trees in a pummelo orchard in Calauan, Laguna, were sprayed with five insecticides at the following dilutions per 100 gallons water:

Systox	½ pint
DDD, a 50% wettable powder	2 pounds
Methoxychlor, a 50% wettable powder	2 pounds
Endrin, 19.5% emulsifiable concentrate	1 pint
EPN, a 25% wettable powder	2 pounds

The sprays were applied with the Bean type spray gun at an operating pressure of 150 to 200 psi. An average of 2.5 gallons was sprayed on each tree in each application.

Five blocks, each representing a row of single-tree plots, were used. Twenty young fruits on each tree, ranging in diameter from 2½ to 3½ inches, were tagged. Pretreatment count was made on August 10 to get the extent of injury on the young fruits. The first spraying was done on September 30. Subsequent sprayings were done on October 12, October 28, November 17, and December 5, 1955.

Two months before harvest all systox treatments in this and the next experiments were stopped for fear of systox build-up in the fruits.

Results and discussion. The first observation, which was a pretreatment count, showed differences between the means of the insecticide treatments and the control, but such differences were insignificant (table 2). In all the remaining observations the differences between the checks and the insecticide treatments were significant. The results indicate that the best treatment was EPN, closely followed by endrin.

On December 12 the fruits were harvested. The intensity of attack, as shown by the number of swellings without holes and larval entrance and emergence holes, was recorded for each of 50 fruits to a treatment. All the insecticide treatments reduced significantly rind borer infestation (table 3). Although endrin and EPN were the most effective of the five insecticides, they failed to give complete control in any of the five replicates.

TABLE 2.—*Percentage of Siamese pummelo attacked by rind borer in plots sprayed with five organic insecticides*

INSECTICIDE	DATE OBSERVED 1955				MEAN
	Sept. 28 [a]	Oct. 14	Oct. 31	Nov. 22	
Systox	12.57	5.61	5.80	7.34	7.83
DDD	11.30	5.94	5.61	5.18	7.01
Methoxychlor	12.89	9.72	7.28	6.02	8.98
Endrin	12.45	3.46	4.43	2.82	5.79
EPN	11.00	3.00	3.33	2.66	5.00
Check	14.49	10.64	11.02	9.28	11.36
SMD (T) at 5%	[b]	3.36	2.83	2.87	
SMD (T) at 1%	[b]	4.58	3.86	3.91	

[a] Pretreatment count.
[b] Insignificant.

TABLE 3.—*Average number of swellings without holes and entrance and emergence holes in each of 50 fruits to a treatment*

INSECTICIDE	BLOCK					TOTAL	MEAN
	A	B	C	D	E		
Endrin	9.58	5.46	5.05	0	0.66	20.75	4.35
Systox	6.37	6.60	7.45	5.34	4.50	30.26	6.05
Methoxychlor	7.00	8.76	8.43	6.94	3.66	34.79	6.95
DDD	9.22	4.60	6.09	5.23	1.50	26.64	6.32
EPN	1.50	7.15	4.50	2.42	6.66	22.23	4.44
Check	11.00	14.00	13.33	9.38	6.20	53.91	10.48
Total	44.67	46.57	44.85	29.31	23.18	188.58	

SMD (T) at 5%—3.19
SMD (T) at 1%—4.35

EXPERIMENT 3: EFFECTS ON THE BORER ON SIAMESE PUMMELO OF EPN, ENDRIN, AND SYSTOX

Materials and methods. Young fruiting trees in the orchard in Calauan were sprayed with the same insecticides at the same dilutions used in experiment 2. An average of 80 fruits to a treatment was used. Since there were very few young fruits of one size at the start of the experiment, fruits varying from 2 to 4 inches in diameter were used. A pretreatment count of infestation was made on September 28. Spray applications were made on September 30, October 12, October 28, November 17, December 5, and December 22, 1955.

Results and discussion. The infestation at the start of the experiment was generally low, averaging 7.25 per cent (table 4). Except for a break in the third and fourth observations (October 31 and November 22), this low infestation was observed until the end of the experiment. The low infestation on October 31 may be attributed to the combined effects of the sprays and unfavorable weather conditions. The increased infestation on November 22 may have been caused by new broods from the unsprayed trees. In this test EPN was the best, followed by endrin and systox.

TABLE 4.—*Percentage of Siamese pummelo attacked by rind borer in plots sprayed with three organic insecticides*

INSECTICIDE	DATE OBSERVED 1955				1956			MEAN
	Sept. 28[a]	Oct. 24	Oct. 31	Nov. 22	Dec. 12	Jan. 4	Jan. 23	
EPN	7.25	3.30	1.68	1.05	1.46	2.38	1.74	2.69
Endrin	6.75	6.13	2.12	1.91	2.63	2.11	3.25	3.56
Systox	7.12	3.14	1.29	3.56	3.92	2.63	3.65	3.61
Check	7.87	5.95	3.21	9.23	6.49	6.75	7.15	6.66
SMD (T) at 5%	[b]	1.99	[b]	3.10	2.41	2.70	2.96	
SMD (T) at 1%	[b]	[b]	[b]	4.45	3.46	[b]	[b]	

[a] Pretreatment count.
[b] Insignificant.

EFFECTS ON MITES

In the experiment at Lipa, DDT, parathion, and dieldrin sprays increased mite injury. This injury became more apparent in the later part of the experiment. The same effect of DDT and parathion was observed by various workers in other countries.[4, 5, 6] No build-up of mites, however, was noted on the systox- and endrin-treated plants. In fact there were indications that these insecticides reduced mite population. Jeppson and Ortega reported that systox showed promise as control material against mites on citrus in California.[7]

In a preliminary experiment conducted jointly by the Departments of Entomology and Plant Pathology in the same farm at Lipa using combination sprays, EPN reduced Tetranychid mite population, but the fungicide Zerlate increased it tremendously. It is prob-

[4] W. Ebeling, *Jour. Econ. Entom.*, 40, 619 (1947).
[5] J. T. Griffiths and W. L. Thompson, *Jour. Econ. Entom.* 40, 386 (1947).
[6] Herbert Spencer and Paul A. Norman, *Citrus Indus.* 33, 11 (1952).
[7] L. R. Jeppson and J. C. Ortega, *Citrus Leaves*, 34, 6 (1954).

able that this increase of mites was brought about by the toxic effect of the fungicide on fungi parasitic on the mites. Norman and Spencer found that EPN 300 gave excellent control of citrus mites in Florida.[8]

The same effect of EPN, endrin, and systox on Tetranychid mites on Siamese pummelo was observed in the experiments conducted at Calauan, Laguna.

[8] Paul Norman and Herbert Spencer, *Citrus Indus.* 33, 10 (1952).

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The idea of research as something separate from teaching is not a true representation of investigation in a university. Curiosity and the satisfaction of curiosity are inherent in the normal function of a university—including instruction. By utilizing the training values of its research activities, the university can be self-perpetuating, for it thus develops its successive incumbents and maintains those things that are of enduring importance.

—*Ohio State University Research Foundation*

MARKETING PALAY IN HANGGAN, BAY, AND LECHERIA AND BANLIC, CALAMBA, LAGUNA [1]

C. D. Kearl, C. D. Villanueva, and A. N. Pagaduan

In Hanggan, Bay, most of the palay was sold from May to July and December to January. The palay was transported to market and to the mill by train, jeep, calesa, and, in many cases, on the farmers' shoulders. Only the palay kept for home consumption was milled, at 40 centavos per cavan milled when the owner got back the rice bran and free of charge when the miller kept the bran. Some operators deposited their palay for home consumption at the mill just after harvest.

In Lecheria and Banlic, Calamba, many of the farmers marketed their palay during the harvest months of October to November and April to May. Most of the palay stored temporarily was placed in *taclabs*. More permanent storage was done in the farmers' houses and in storehouses. The palay was hauled on sleds, in carts, calesas, and jeeps, and on the farmers' shoulders. About 85 per cent of the farmers milled their palay at *kiskisan* mills at a charge of 35 to 40 centavos a cavan. Discounts were given to farmers who left the rice bran at the mill.

The common marketing problems were (1) the necessity of selling immediately after harvest in order to obtain cash for living and paying bills, (2) lack of a definite marketing organization, (3) lack of knowledge about prevailing price conditions, (4) inadequate transportation facilities.

Farmers and consumers alike are interested in specific information that will serve as a basis for improving the present marketing system. To obtain such information three barrios in Laguna were surveyed in the summer of 1953. Ninety-eight records were taken in the barrios of Lecheria and Banlic, Calamba, and 93 in Hanggan, Bay.

THE AREAS

Lecheria is in the eastern part of the town of Calamba, less than 1 kilometer from the center. Banlic is in the western part of the town about 2 kilometers from the poblacion. Both have good roads permitting ease of travel and transportation at any time of the year. The farms are irrigated, fairly productive, and capable

[1] Central Experiment Station Contribution No. 1895. Taken from theses presented by the junior authors for graduation with the degree of Bachelor of Science in Agriculture from the College of Agriculture.

of growing two crops a year. The irrigation water comes from a river which flows across the town.

Hanggan is in the southeastern part of Bay bordering on the municipality of Calauan. The barrio has a good irrigation system. The eastern part of the barrio tends to be flooded so that the farmers must wait for the water to subside before they can prepare their land for planting. Some of the farms in this area have such a low hard pan that work animals can not be used to advantage.

THE FARM OPERATORS

The farm operators in Lecheria and Banlic were slightly older, averaging 40.4 years, and had resided in the barrios and operated their farms longer than those in Hanggan (table 1). The average age of the farmers in Hanggan was 36.9 years. Since the average residence in the barrio was only 17.1 years it is obvious that many of the farmers had moved in rather recently.

TABLE 1.—*Age and experience of farmers*

ITEM	FARMERS	
	Hanggan	Lecheria and Banlic
Number	93	98
Age, years	36.9	40
Residence in barrio, years	17.1	32.6
Engaged in farming, years	15.6	18.8
Operated present farm, years	8.1	9.3

The length of farm experience was proportional to the age, the farmers in Lecheria and Banlic having had somewhat more farm experience, 18.8 years, than those in Hanggan, 15.6 years.

Considering the length of residence in the barrio, the number of years of operating the present farm was only about one more for the farmers in Lecheria and Banlic than for those in Hanggan. Apparently, there was about the same relative stability in the two areas, which is surprising considering that the farmers in Hanggan had shorter residence in the barrio.

THE FARMS

Ownership. Practically all of the farm operators in Hanggan were tenants. About 13 per cent acted as temporary owners of the land they operated. These farms were formerly swampland with few

trees but with thick grass. The operators, in return for clearing the land without any cash compensation from the landlords, were allowed to cultivate the land for a given period with no share going to the landlords. The period ranged from 3 to 5 years depending on the condition and location of the area cleared. After this period the operators became regular tenants.

In Lecheria and Banlic the farming areas are older and more settled. In these barrios 87 per cent of the farmers were regular tenants, 11 per cent being owner-operators.

Size of farm. The average size of farm in Hanggan was 1.8 hectares (table 2). The size was almost the same in Lecheria and Banlic. The owners in Lecheria and Banlic had slightly larger farms of 1.8 hectares as compared with the 1.7 hectares of the tenants.

TABLE 2.—*Size of farm*

FARMER	HANGGAN		LECHERIA AND BANLIC	
	Number of farms	Hectares per farm	Number of farms	Hectares per farm
Tenants	—	—	87	1.7
Owners	—	—	11	1.8
All farms	93	1.8	98	1.7

Livestock. In both areas similar kinds of livestock were kept (table 3). Farms in Lecheria and Banlic tended to keep slightly more livestock. The usual pattern in both areas was about one work carabao per farm. There was an average of one pig and 15 chickens per farm.

TABLE 3.—*Livestock*

KIND	AVERAGE NUMBER PER FARM	
	Hanggan	Lecheria and Banlic
Work carabao	.8	.8
Other carabao		.1
Cattle	[a]	.1
Horse		.1
Pig	.7	1.0
Chickens	14.1	19.8
Duck	.4	.2

[a] Less than .1.

Crops grown. In both areas rice was the principal crop grown by all farmers. Minor crops, grown mostly for home consumption, were corn, gabi, sweet potato, eggplant, sitao, squash. Bananas were the only fruit grown.

A breakdown of the use of land was not available for Hanggan. For Lecheria and Banlic there was considerable difference between owners and tenants (table 4). The tenants' land was mostly in lowland rice, whereas owners grew significant proportions of lowland rice, upland rice, and other crops.

TABLE 4.—*Use of land in Lecheria and Banlic*

KIND	OWNERS		TENANTS	
	Hectares	Per cent	Hectares	Per cent
Crop land:				
Lowland rice	0.70	38	1.42	83
Upland rice	0.50	27	.24	14
Other	0.45	25	.04	2
Farmstead	0.20	10	.01	1
Total	1.85	100	1.70	100

Production of palay. The total production of palay per farm and per hectare was about the same for farms in the barrio of Bay and those in Calamba (table 5). Both areas were generally two-crop areas and yields were good in both. In the one barrio of Bay the yields averaged 161 cavans per farm and 101 per hectare. In the two barrios of Calamba they were 162 and 102 cavans.

TABLE 5.—*Production of palay in cavans*

YIELD	HANGGAN	LECHERIA AND BANLIC
Per farm	161	162
Per hectare	101	102

DISPOSITION OF PALAY

Division of production. In Hanggan and in Lecheria and Banlic the division of palay among the various persons involved in the production process was about the same. About 25 cavans went to the harvester, 60 cavans to the landlord, and 76 cavans to the operator in Hanggan (table 6). In Lecheria and Banlic the number of cavans going to the harvester was 20. The landlord received approximately

64, and 78 went to the operator. Only slightly more went to the harvester in Hanggan, Bay, than to those in the Calamba barrios.

TABLE 6.—*Disposition of palay*

SHARER	HANGGAN		LECHERIA AND BANLIC	
	Cavans	Per cent	Cavans	Per cent
Harvester	25	15	20	13
Landlord	60	38	64	39
Operator	76	47	78	48
Total	161	100	162	100

Disposition of operator's palay. In Hanggan approximately 37 cavans of palay were sold (table 7). An additional 8 cavans were given to creditors in payment of debts. Seed took 3.3 cavans, leaving approximately 28 cavans for the farmer's use. In Lecheria and Banlic the amount sold was considerably higher, averaging 52 cavans, or approximately 2/3 of the operator's share. Only a very small part went to the creditors. The amount used for seed was the same as in Hanggan. The farmers consumed substantially less rice in this area than in Hanggan.

TABLE 7.—*Disposition of operator's share of palay*

USE	HANGGAN		LECHERIA AND BANLIC	
	Cavans	Per cent	Cavans	Per cent
Sold or bartered	36.8	49	52.4	67
Given to creditors	7.7	10	.7	1
Seed	3.3	4	3.3	4
Eaten or to be eaten	27.8	37	21.7	28
Total	75.6	100	78.1	100

Tenants' versus operators' disposition. In Lecheria and Banlic a comparison of the tenants' and the operators' disposition of their palay indicated that the total production per tenant farm was much larger (table 8). This was because a larger proportion of the land was in palay, as previously noted. The tenants produced approximately 168 cavans of palay. Ninety-two of these went to the harvester and the landlord. Because of the greater harvest a larger amount went to the harvester. Of the balance that remained the farmers consumed 21 cavans and sold 50. Both of these items are considerably less than the amounts consumed and sold by the owners.

TABLE 8.—*Tenants' versus operators' disposition of palay, Lecheria and Banlic*

USE	TENANTS		OWNERS	
	Cavans	Per cent	Cavans	Per cent
Harvester	20.9	12	14.7	12
Landlord	71.6	43	—	—
Operator:				
Creditors	.9	1	—	—
Seed	3.4	2	2.9	2
Food	20.7	12	29.8	25
Sold or bartered	50.1	30	70.2	61
Total	167.6	100	117.6	100

It would appear that the farm owners were under less pressure to produce large amounts of palay and were willing to live on the income from the investment in their land. Because no share went to the landlord there was more palay available for use even though the total production was less. The average consumption per family of owners was approximately 30 cavans. Seventy cavans of palay were sold as a source of income.

Disposition of different types of palay. The two types of palay which were produced in Lecheria and Banlic were glutinous and nonglutinous. The shares going to the harvester and to the landlord were approximately the same for each type (table 9). Glutinous rice was not consumed at home but was almost entirely sold. Only a relatively small amount was retained for seed. About half of the operator's share of nonglutinous rice was sold or used as seed. The other half was consumed by the family.

TABLE 9.—*Disposition of types of palay, Lecheria and Banlic*

USE	PER CENT	
	Glutinous	Nonglutinous
Harvester	12.5	12.5
Landlord	38.6	39.7
Operator:		
Creditors	0.1	0.8
Seed	2.3	1.9
Food	0.1	23.5
Sold or bartered	46.4	21.6
Total	100.0	100.0

Prices received. The nonglutinous rice in Hanggan, Bay, and Lecheria and Banlic, Calamba, commanded a considerably smaller price than the glutinous rice. The prices in Hanggan were ₱13.09 for glutinous rice and ₱9.56 for nonglutinous rice, a difference of approximately ₱3.50. In Calamba the prices were ₱12.58 for glutinous rice and ₱8.91 for nonglutinous, again a difference of approximately ₱3.50.

Marketing of rice in Hanggan. Palay was cleaned by the harvesters with the use of winnowing baskets. The farmers had to clean the palay again in a winnowing mill after drying. Because there were no warehouses in the area the farmers had to send the extra palay to three rice mills in the town of Bay. Most of the palay was sold during the months of May to July and December to January.

One of the most important problems of the farmers was transportation. The only transportation available to the farmers in the eastern part of the barrio was the train, which made a limited number of trips a day. Near the main road jeeps and calesas were used for transporting palay to market and to the mill. In many cases, no transportation facilities were available and the farmers carried the palay on their shoulders. The rice mill operators were responsible for transporting the palay from the train station to the mill when the owner of the palay rode on the train.

Only the palay kept by the operators for home consumption was milled. Some farm operators deposited the palay kept for home consumption at the mill just after harvest. This forced them to have their palay milled at the rice mill where it was stored. The usual rate of milling was 40 centavos per cavan milled, with the owner of the palay getting the rice bran. There was no charge for milling when the rice bran was left to the miller. There was no charge for storing.

The farm operators did not have up-to-date information on the marketing situation and were limited in their information on prices given by buyers at harvest time.

Marketing of rice in Lecheria and Banlic. The buyers of palay in the barrios were traveling buyers, local palay merchants, landlords, and barrio consumers. The traveling buyers were from Biñan, Sta. Rosa, Bay, and San Pablo City. The local merchants were from Calamba and Cabuyao. Usually the cash buyers were traveling buyers or local palay merchants.

The months of harvest were October and November (wet-season harvest) and April and May (dry-season harvest). Many of the farmers marketed their palay during the harvest months. This was probably due to the inability of the farmers to store palay because of lack of storage facilities.

Most of the palay which was stored temporarily immediately after harvest was placed in *taclabs*.[2] A few farmers took the grain to their homes. The more permanent storage was done in the farmers' houses and storehouses, or *camaligs*.

The palay was hauled from the field to the homes in the barrios on sleds, carts, calesas, or jeeps. Many farmers, however, carried the grain on their shoulders. All farmers used sacks for their palay, and in some cases containers such as bamboo baskets and boxes.

About 96 per cent of the farmers milled their palay at *kiskisan* mills in the barrios. Four per cent used mortar and pestles. The milling charge ranged from 35 to 40 centavos for each cavan. Discounts were made to farmers who left the rice bran at the mill. In hauling the palay to the mill some farmers used carts, calesas, and jeeps. Most, however, carried the palay to the mill on their shoulders.

Major problems of marketing palay in these areas were (1) the necessity of selling immediately after harvest in order to obtain cash for living and paying bills, (2) lack of a definite marketing organization, (3) lack of knowledge about prevailing price conditions, (4) inadequate transportation facilities.

[2] A temporary storage place for threshed palay out in the field.

AUREOMYCIN SOLUBLE (UNREFINED) FOR PREVENTING PIG SCOURS

The study to determine if aureomycin soluble would prevent pig scours under local conditions was conducted in the Department of Animal Husbandry from June, 1955, to March, 1956.

Five litters of Berkshire and Berkjala pigs were assigned to lot I (without aureomycin) and five to lot II (given aureomycin). Two Berkjala and three Berkshire sows were added to each lot. At the start of the experiment there were 15 males and 18 females in lot I and 13 males and 24 females in lot II. Except for the aureomycin which was added to the drinking water of lot II at the rate of 100 mg. per gallon, management and care of the two lots were the same.

Of the 31 sucklings in lot I 28 came down with the scours; of the 36 sucklings in lot II 5 got the scours. This observation strongly points to the beneficial effect of aureomycin, but it is felt that any conclusion made should be tentative until confirmed by further trials.

There was no significant difference between the two lots in weight increments during the period of observation.

—J. A. Eusebio

MUNGO IN RATIONS FOR LAYING PULLETS

Studies at the College have shown that a certain part of the fish meal in rations for chicks may be satisfactorily replaced by mungo meal. This further study was conducted to determine if such a replacement would improve egg production.

Two lots of 30 pullets each were given the following rations in the form of dry mash for 362 days:

	LOT I	LOT II
Ground corn (yellow)	5	5
Rice bran	2	2
Copra meal	1	1
Fish meal	2	1
Mungo meal	—	3

Except for the ration the two lots were given identical care.

At the end of the experiment, there were no significant differences between the two lots in body weight of birds and in number and percentage of egg production. However, the lot given mungo meal produced lighter and costlier eggs and had a greater mortality.

—Elpidio C. Coligado and F. M. Fronda

ERRATA

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The Philippine Agriculturist

(Formerly The Philippine Agriculturist and Forester)

Published by the COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
UNIVERSITY OF THE PHILIPPINES

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